Materials & Methods

FEBRUARY
1953

Aluminum in Electrical Applications

A Critical Look at White Brass Plated Coatings

Fused Quartz as an Industrial Material

New Castable Foam Plastics

Zirconium Now Fabricated by Powder Metallurgy

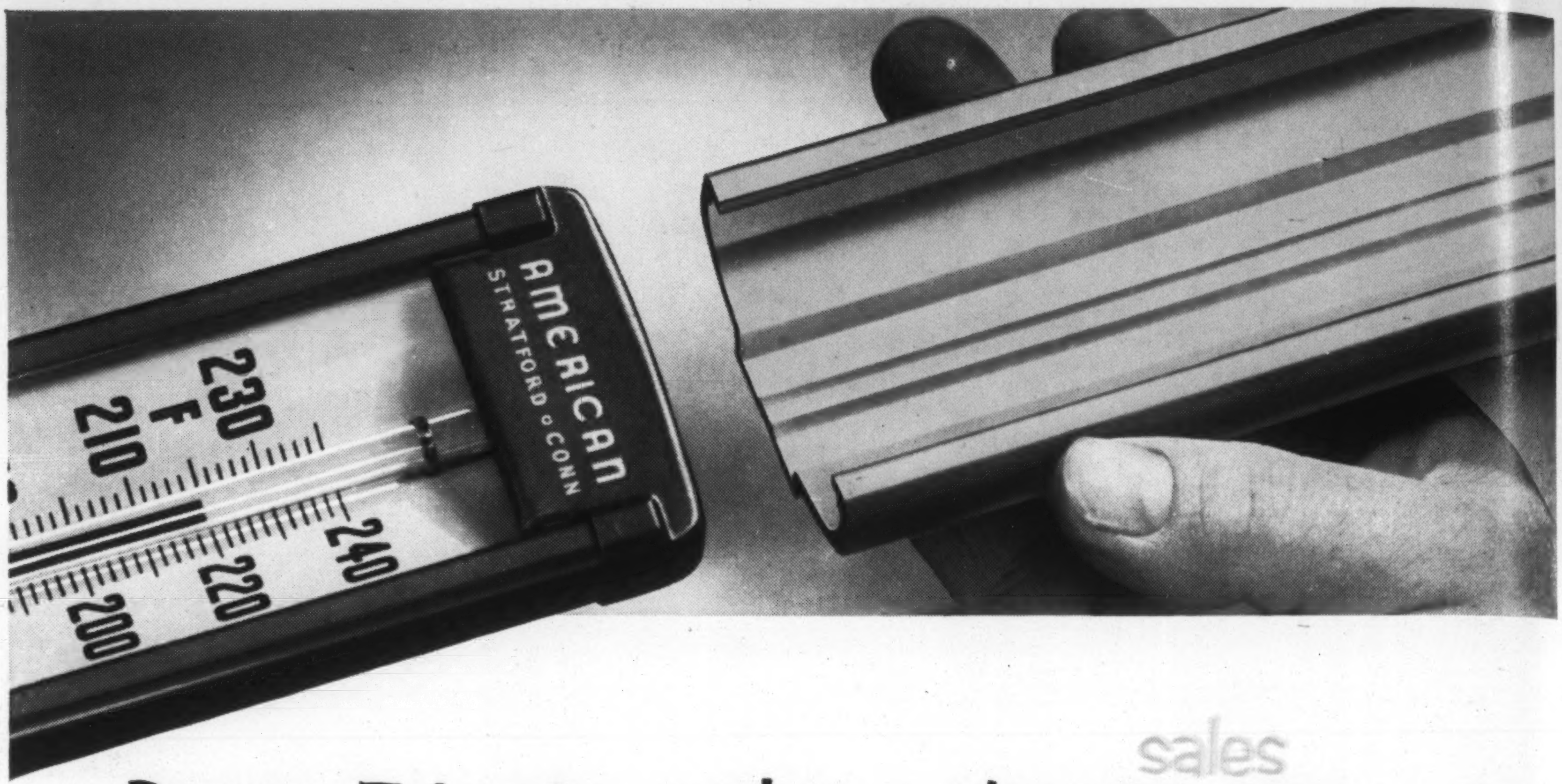
Centrifugally Cast Steel Tubing

New Spot Welding Technique for High Alloys

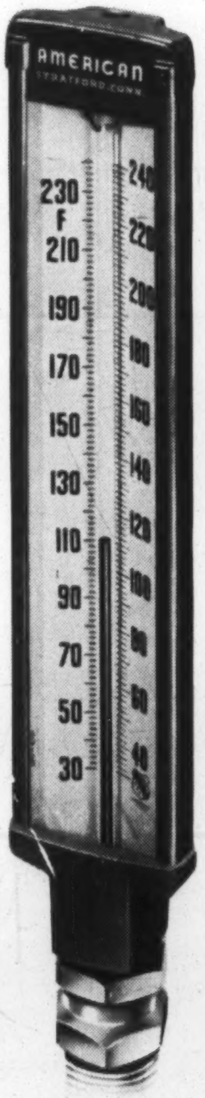
How Cold Treatments Improve Performance of Materials

GLASS-REINFORCED PLASTICS
—Materials & Methods Manual No. 91

THE MAGAZINE OF
MATERIALS ENGINEERING
DEVOTED TO THE MATERIALS PROBLEMS OF PRODUCT DESIGN AND MANUFACTURE



Bronze Extrusion makes a stronger sales case for this industrial glass thermometer



The case for this "American" Industrial Glass Thermometer made by Manning, Maxwell & Moore, Incorporated, Stratford, Conn., used to be a steel stamping. Now it's made of ANACONDA Extruded Bronze.

Why the change? Because this extruded bronze shape makes a far stronger and more rigid case; it's easier to produce; it simplifies assembly—and adds additional quality to an already high-quality product. So accurate are these bronze extrusions that neither straightening nor machining is needed for assembly. And assembly time itself is cut.

For the base, an ANACONDA Brass Die Pressed Forging is joined to the case by brazing to provide greater joint strength. By machining the appropriate face of a single-style base forging, a stem connection can be provided at any angle.

ANACONDA Brass and Bronze have long been making a stronger "case" for products—by simplifying production; by the higher quality that is always associated with products made of brass or bronze; by increasing sales appeal. We urge you to consider the advantages of these metals for your manufacturing processes and your products. For information, write to The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

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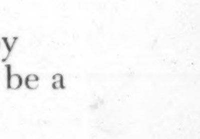

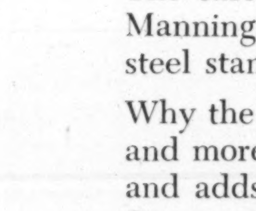

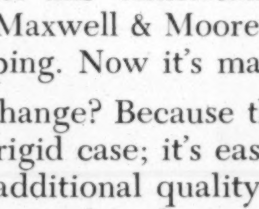

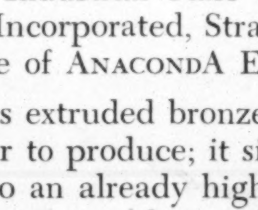

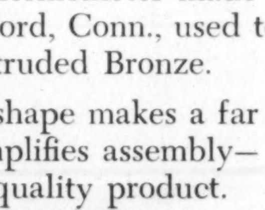

Base forging can be machined to provide stem connection at any angle and direction.

Extruded case and forged base for this 9-in. "American" Thermometer are joined in perfect alignment by brazing. No machining or straightening is required.

ANACONDA® —the name to remember in COPPER—BRASS—BRONZE

Materials & Methods®

THE MAGAZINE OF MATERIALS ENGINEERING • VOL. 37, NO. 2 • FEBRUARY, 1953

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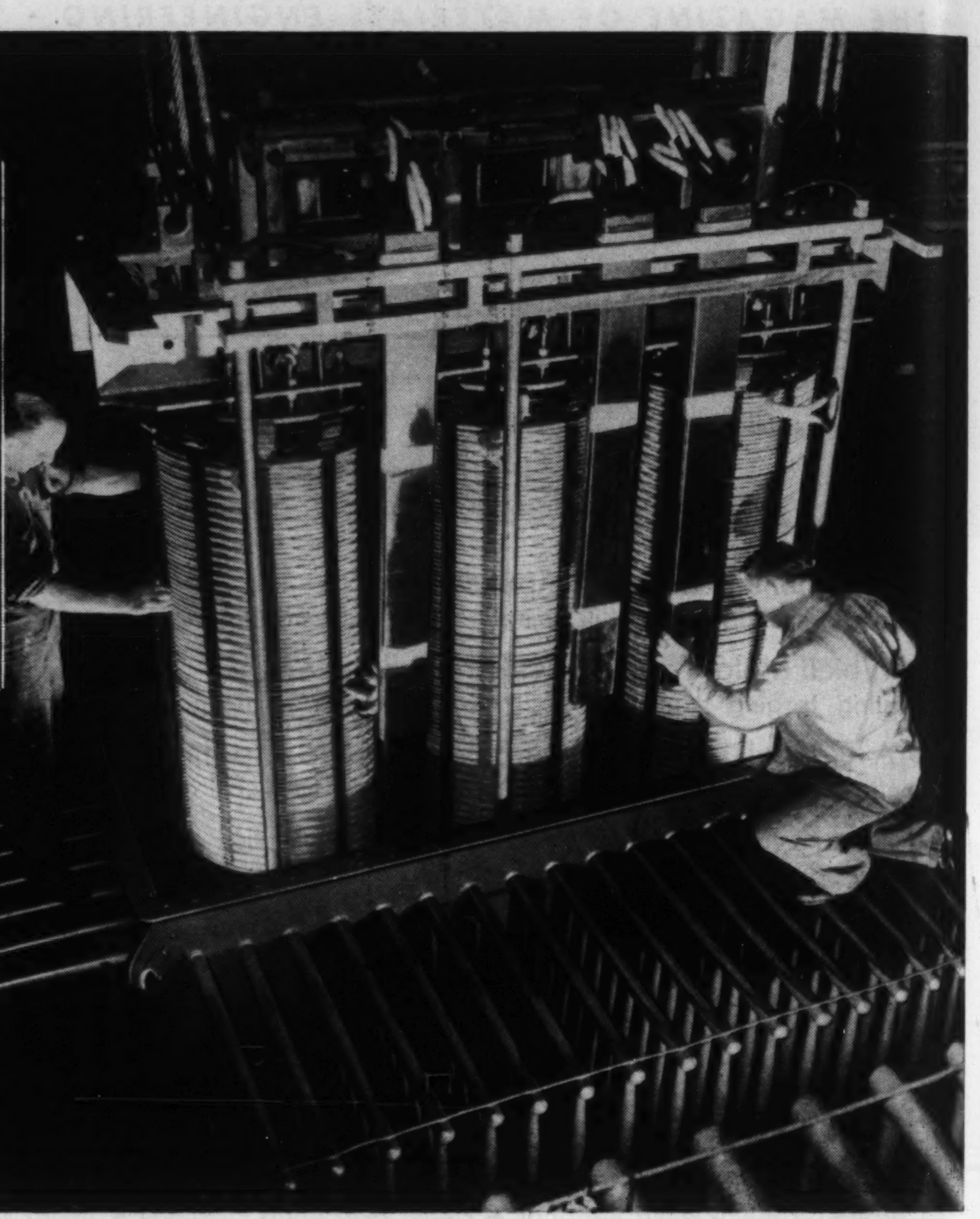
Another new development using

B. F. Goodrich Chemical ***raw materials***

Typical use of Hycar nitrile rubber for small-sized gasket — on Spirakore Distribution Transformer.



Photos courtesy of General Electric Company, Schenectady, New York. B. F. Goodrich Chemical Company supplies the Hycar rubber only.

GIVES SEALS "9 LIVES"!

Transformer gasket made of Hycar boasts many improvements

GASKETS for sealing giant transformers like the one pictured used to cause many problems. Leakage was the worst. If liquid leaked out, or water or moist air leaked in, operating efficiency dropped and service and maintenance costs went up.

But when Hycar nitrile rubber was tried, engineers found in it the nine important gasket material advantages they'd been looking for.

See what Hycar nitrile rubber does!

It resists attack by hot insulating oil or Askarel

Will not swell in contact with hot insulating oil

Does not contaminate insulating oils

Resists permanent deformation under compression

Ages well

Has low permeability to water vapor

Is reasonable in cost

Seals without use of adhesives

Has excellent physical properties for assembling

Hycar nitrile rubber compounds have helped solve many difficult problems—have helped improve and develop many saleable products. Perhaps Hycar is just what you're looking for. Helpful information for the asking — just write Department HR-1, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

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American Rubber

GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers • HARMON organic colors

The Materials Outlook

European metallurgical developments . . . . England has new process for producing titanium. It is not electrolytic or a modified Kroll process . . . . British aluminum alloy with about 15% titanium carbide has modulus of about 23,000,000 psi . . . . British jet blades of titanium carbide impregnated with about 50% nickel show greater ductility than 30% nickel American blades. . . . Frenchman has developed process to sinter porous bearings in 1 min to get properties equivalent to those obtained by usual ½-hr schedule.

Titanium is being considered for the rocket-firing wing tip pods on the Northrup Scorpion F-89D fighter plane. This assembly was chosen for research because it involved a larger variety of forming, machining, welding and other fabrication techniques than any composite unit of comparable size.

Cobalt-60 continues to gain interest as radiation source. . . . Largest source (rated at 4500 curies) outside AEC installations has been delivered to Stanford Research Institute. This source is stronger than a 1,000,000-v x-ray machine. It is equivalent to $80 million worth of radium. . . . A commercial supplier is offering two-day courses to provide basic knowledge needed to handle cobalt-60 in industrial radiography.

Rare earth elements may go into large scale production. Argone Laboratory announced development of a continuous extraction process feasible on an industrial scale. Main commercial interest in rare earth elements is as alloying elements for steel and magnesium.

Noncombustible aircraft wing anti-frosting and anti-icing compound is reported. Material is said to eliminate fire hazards met with other de-icing compounds.

Longer lasting rubber products are promised by two new developments. . . . A rubber-like material is highly resistant to ozone (a primary cause of rubber deterioration in air). It imparts ozone resistance to rubbers compounded with it. . . . Another company has made GR-S extra tough by adding rosin chemicals. Abrasion resistance is increased 30 to 40%.

Sintered aluminum powder is being pushed for relatively elevated temperature (400 to 800 F) applications. Strength retained in this range is

(Continued on page 4)

The Materials Outlook *(continued)*

much superior to that of available aluminum alloys. The catch is the cost of the material. In extrusion billet form, price is about $1.25 per lb.

Adhesive developd by Battelle Memorial Institute is not dissolved by water, alcohol, oils, naphtha and other organic solvents. It hardens without heat or drying. Easy application, durability and excellent bond to metals are outstanding advantages.

New synthetic rubber developed in Germany is described by American rubber researchers as a "super-elastic." It stands up better in tires than anything developed here. Tires of the new material will outlive a car; shoe soles will outwear two pairs of uppers. At present, cost is 10 times the price of GR-S. Quantity production might bring that down to 2 to 3 times GR-S price. German applications include belts, sponges, heels and soles. It can be made in syrup form and poured in a mold. Tensile strengths reach 8000 psi. Resistance to tear, abrasion and combustion are called "unbelievable" by Americans. In this country, the new material is believed to be two or three years away from the commercial market.

New heat insulating material ten times as efficient as anything now in use is under development by General Electric. Prototype refrigerator-freezer using the material has walls ½ in. thick. The new product is still developmental and is not yet ready for marketing.

High vacuum melting furnace affording larger charges of purer alloys than previously possible has been installed at the Naval Ordnance Laboratory. The furnace will take a charge of 200 lb of ferrous materials, melting them in a vacuum of about 1001 mm of Hg. The metal is heated by a high-frequency coil.

Transistor using germanium to do the job of a full-size vacuum tube is used in new commercial hearing aid. This is claimed to be the first transistor application in a consumer product. . . . Experimental models of a portable television receiver (tubeless except for picture tube), radio receivers, loudspeaker systems, miniature radio and TV transmitters and several musical instruments have been made with transistors.

Cold rubber can be made cheaper and 50 times faster by new method announced by B. F. Goodrich.

Only 11 materials, including 10 metals, are on DPA most critical list. These are: titanium, cobalt, columbium, molybdenum, nickel, tantalum, heavy (over 3000 lb) gray iron, gray iron alloy and carbon steel castings, nickel stainless steel, and diamond bort. . . . Aluminum, beryllium, selenium, platinum, copper, lead, tin, zinc; tungsten; alloy steel bars, heat resistant alloy steel castings, plates and structural shapes have come off most critical list since beginning of 1952.

MORE ABOUT THE "MATERIALS SHOW"

A Message from the Publisher

Last month M & M's editor, Ted Du Mond, was appointed general chairman of the technical conference to be held during the Exposition of Basic Materials for Industry, June 15-19, 1953. His position as editor of industry's only materials magazine makes, we believe, this selection an ideal one. Further information on the conference will be found in our News Digest section immediately following this page.

In our December issue, on this page, I urged our readers and advertisers to support this new Materials Show. Due to the early closing of that issue, four of the twenty-one sponsoring companies were omitted in this earlier announcement. It is with a great deal of pleasure, therefore, that I now correct this omission by adding the names of Mr. H. B. Trix, president of W. M. Chace Co., O. R. Cheatham, president of Georgia-Pacific Plywood Co., Dr. M. H. Meighan, director of research of Johnson Bronze Co., and S. H. Stupakoff, president of Stupakoff Ceramic & Manufacturing Co.

Once again I wish to emphasize the fact that the Materials Show has been designed specifically for exhibits of basic engineering materials used in product design and manufacture. This means producers and suppliers of irons and steels, nonferrous metals, nonmetallic materials, component parts and shapes made from these materials groups, and finishes and coatings. As the exposition management firm of Clapp & Poliak, Inc. points out, machinery and equipment necessary to demonstrate the characteristics and applications for materials will play a secondary role.

I am sure our readers will be glad to learn that nearly 75 companies have already signed up for space at the Show. Products to be exhibited by these companies include aluminum, plastics, diamonds, ceramics, steel, felt, extrusions, tin, precious metals, castings, glass, rubber, clad metals, stampings, copper, paper, metal powder parts, wood, carbides, lead, nonmetallic parts, coatings and finishes.

It follows, therefore, that all industrial and technical people who are interested in materials and their industrial applications should plan to attend the First Exposition and Conference of Basic Materials for Industry. Materials engineers, project engineers, designers, development and research men, metallurgists, production men, purchasing, sales and technical management men—any and all men in these title-groups interested in materials should plan to attend. The Materials Show is being held not for any one specific title-group but for men in all title-groups who have an interest in materials.

The number and diversity of the materials exhibitors signed up so far are indeed most encouraging. The enthusiastic cooperation and help Ted Du Mond, our editor, is receiving from industry's outstanding materials men—both producers and consumers—is a source of great satisfaction. The success of the First Exposition and Conference of Basic Materials for Industry seems assured.

William P. Winsor
Publisher

Materials Show Conference to Help Users of Materials

Three-Day Meeting Will Highlight Economic Aspects of Materials and Parts Selection

A three-day conference to discuss the new as well as established engineering materials available to manufacturers will be held at the Hotel Roosevelt in New York, June 16-18. The conference will supplement the first Exposition of Basic Materials for Industry which will be held at Grand Central Palace, New York, June 15-19.

The combined events will provide the first clearing house of information ever attempted in the entire field of materials for product manufacturing. Heads of more than 20 leading companies have formed a board of sponsors for the show and conference. Don G. Mitchell, president, Sylvania Electric Products, Inc., heads this sponsoring committee.

Theodore C. Du Mond, editor, MATERIAL & METHODS, will serve as general chairman of the three-day technical conference. Morning sessions of the three-day meeting will be devoted to the broad, general aspects of material selection, while afternoon sessions will be given over to technical, engineering considerations of the properties of new and old materials.

One session will be devoted to consideration of economic factors of new materials already developed and those in the research stage. An effort will be made not only to describe the characteristics of these materials but also to discuss them in terms of availability, comparative costs with competitive materials, their capabilities and limitations.

Another session will discuss the role of materials, with special emphasis on the coordination of materials with production and design. The problem will be studied from the standpoint of efficiency in use, sales appeal, cost and the type of fabricating equipment needed.

Other meetings will include the organization and operation of materials engineering departments capable of keeping abreast of developments and research; the development and use of books specifying standards for materials; the use of standards for sizes and composition; sources of information about new materials, and special use of materials for high strength, for production at high temperatures, and for withstanding of corrosive elements.

More than 2000 materials experts are expected to be on hand at the combined exposition and conference to answer questions for an anticipated 15,000 visitors. In addition to new materials, the older and standard materials will be shown with attention to new applications.

Admission will be restricted to management executives, and engineers and technical personnel, including materials engineers, project engineers, product designers, production experts, research men, and sales and marketing executives.

Further information on attending the conference may be obtained from Clapp & Poliak, Inc., the exposition management, 341 Madison Ave., New York 17.

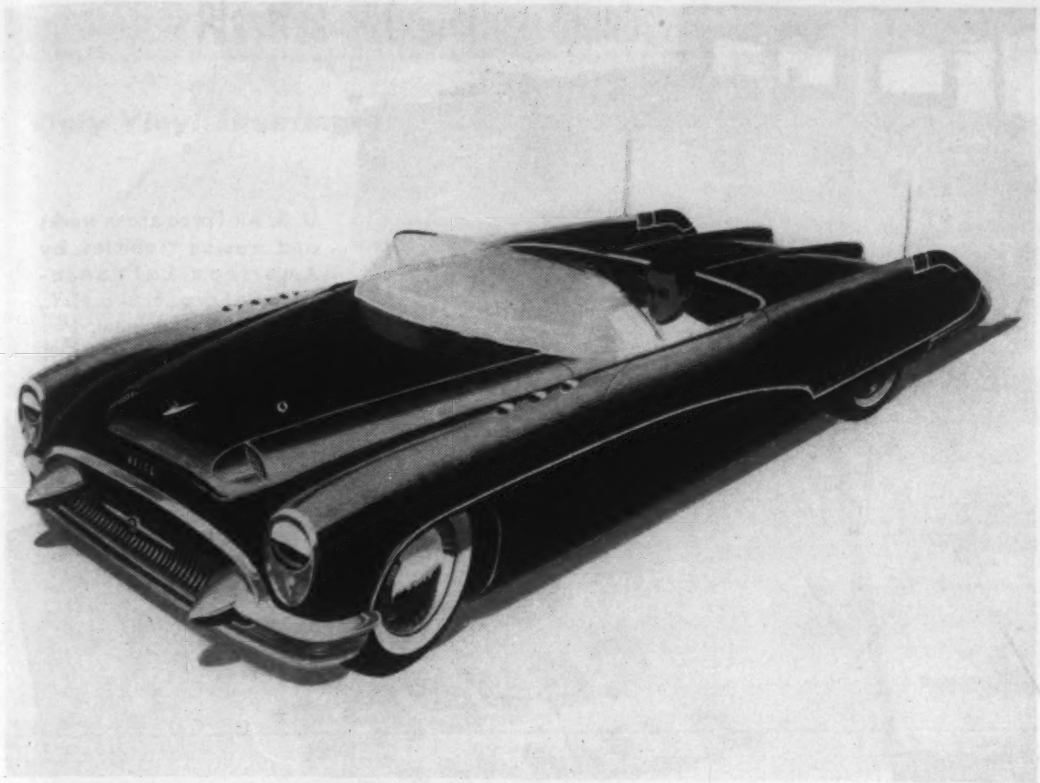
T. C. Du Mond, Materials Show Conference Chairman

Steel Capacity Increased in 1952 to 117 Million Tons—a Record

The steel capacity of the United States went up 8,959,800 tons during 1952—the largest gain ever made in a year—raising the total annual capacity of this country to 117,547,470 net tons, the highest level ever achieved, according to American Iron and Steel Institute.

The new annual capacity figure of the world's largest steel industry is an increase of 25,656,910 tons, or about 30%, in the seven postwar years as a result of steel companies' large scale expansion and improvement programs. It is a gain of over 35.9 million tons, or 44%, in 13 years, since the start of 1940. The latter increase is nearly twice the annual capacity of Great Britain, and exceeds the estimated total capacity of Russia, second largest steelmaking nation.

The Institute announced that the annual capacity is rising towards an expected figure in excess of 123,000,000 tons of ingots and steel for castings. The steel companies' present programs of expansion and improvement indicate that the capacity will be raised by more than 4 million tons during 1953, more than 1 million tons in 1954, and about 500,000 tons after 1954.



Experimental sports car was built by Buick Motor Div. of GMC to test the possibility of using glass fiber reinforced plastics in car bodies.

Reinforced Plastics Production up 40% in 1952

Plastics Society Predicts Similar Rise This Year. New Civilian Applications Expected.

While practically all sections of the Plastics Industry experienced market and production expansion in 1952, one group—the Reinforced Plastics Div.—enjoyed a production increase of approximately 40%, according to The Society of the Plastics Industry, Inc. In spite of this, reinforced plastics is still small business not only from the standpoint of total volume but in the matter of size of individual enterprise. The following is a resume of an SPI report on these materials.

The statistics of the reinforced plastics industry are traditionally based on the amount of polyester resins used. Also used, besides polyesters, are: phenolics, melamines, silicones, epoxys, alkyds and cellulosics. With polyesters, fibrous glass is the main reinforcement; but with these and the other aforementioned resins, other reinforcements are also used in some degree. These include cotton, rayon, nylon, paper and the new synthetic fibers.

Approximately 19 million lb of polyester resins for reinforced plastics products were sold in 1952. This compares with approximately 14 million lb in 1951, about 9 million lb in 1950, and about 7 million lb in 1949. With polyester plastic in 1952, something around 11 million lb of fibrous glass was used.

Prospects this year indicate a probable market for another 40% increase up to the 27 million lb figure for polyester plastics in the reinforced field. And the likelihood is that the proportion of glass used with these resins will increase because of recent improvements in techniques. Well over 16 million lb of fibrous glass will be involved this year.

In point of industry expansion at mold and processing level, the industry now boasts approximately 110 custom molders and a few proprietary molders.

Major companies involved in polyester plastic production are: American Cyanamid Co.; Atlas Powder Co.; Bakelite Co., Div. Union Carbide & Carbon Corp.; General Electric Co.; Glidden Paint Co.; Interchemical Corp.; Marco Chemicals Inc.; Naugatuck Chemical Div., U. S. Rubber Co.; Pittsburgh Plate Glass Co.; Plaskon Div., Libbey-Owens-Ford Glass Co.; Reichhold Chemicals, Inc.; Rohm & Haas Co.; and Schenectady Varnish Co. Total kettle capacity of these polyester manufacturers at the end of 1952 stood at well over 30 million lb, and some expansion is inevitable in 1953.

In the matter of fibrous glass production, expansion was extensive in 1952. Companies making this material are: Ferro Corp.; Glass Fibers, Inc.; Glass Floss Corp.; Libbey-Owens-Ford Glass Co.; Modigliani Glass Fibers, Inc.; Owens-Corning Fiberglas Corp.; Perrault Bros.; and Pittsburgh Plate Glass Co.

There has also been a big expansion on the part of weavers of glass fabrics in plastics reinforcement. Indeed, it appears that for some time to come glass weaving facilities will be more than ample to handle the needs of the reinforced plastics industry.

In point of technique there has been a steady expansion in production by the three or four different manufacturing processes used in this industry. There has been an increase in the use of preforming and an increase in the use, by molders, of preimpregnated fibrous glass material.

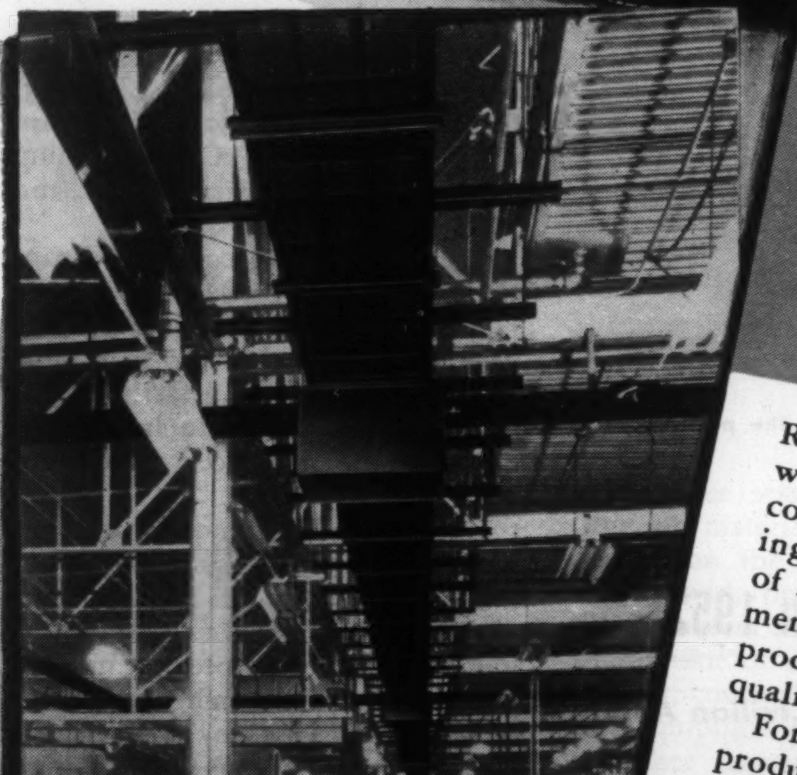
At least six companies now are engaged in coating or impregnating glass cloth and glass mat with polyesters and other resins and delivering them to molders to cut them into shapes ready for molding.

The industry broadened its bases of application during 1952 and expanded the production of such reinforced plastic products as glazing sheets, tote boxes, machine components, housings, piping, boats, fishing rods, sport cars and electrical parts.

This year the variety of applications will continue to expand. Large refrigerator components, construction elements, luggage, furniture, reaction vessels, plating tanks, fresh water tanks, fuel oil tanks, truck tanks for corrosive materials, crude oil storage tanks up to 500-bbl. capacity, hoods and vents in laboratories and chemical resistant operations will show the impact of the broadened application basis for reinforced plastics. [*For complete details on properties and applications of these materials, see "Materials & Methods Manual," No. 91 in this issue of* MATERIAL & METHODS.—The Editors.]

(More News on page 11)

U. S. Air Force crash trucks and rescue vehicles by American-LaFrance-Foamite Corp., Elmira, N. Y., use Revere Aluminum.



Aluminum Conductor Busway, light and economical, by Bull Dog Electric Products Co., Detroit, Mich., uses Revere Aluminum (EC Grade) Bar.

Industry Depends Upon The Versatility Of REVERE ALUMINUM

Revere meets the requirements of industry with a wide range of aluminum alloys in extruded shapes, coiled sheet, drawn tube, electrical bar and forgings. And industry knows the fine, uniform quality of Revere Aluminum. Each customer's requirements, based on their specific uses of Revere products, receives careful attention by Revere quality control.

For assistance in the efficient manufacture of products using aluminum, you are invited to utilize Revere's Technical Advisory Service.

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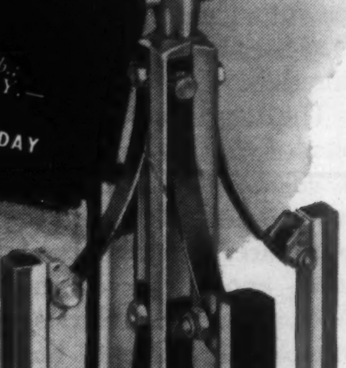
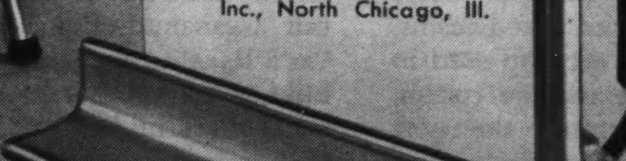
Many makers of indoor and outdoor chairs and furniture use Revere Aluminum Tube. This chair by Lawnlite Co., Miami, Florida.



The heart of this cylinder surfacing hone is a Revere Aluminum Extruded Shape. Photo courtesy Ammco Tools, Inc., North Chicago, Ill.



A Revere Aluminum Extruded Shape is used by the meat packing industry as smoke-sticks for hanging meats during the smoking process. Photo courtesy The Globe Co., Chicago, Ill.

Plastics Production Climbs to New High

Only Vinyl Sheeting and Coated Fabric Did Not Show Pronounced Growth

The plastics industry reached new heights in 1952 after a delayed start the first half. Production of all plastics raw materials totalled approximately 2,600,000,000 lb, according to The Society of the Plastics Industry, Inc. This compares with an actual production figure of 2,431,408,000 lb in 1951.

The dollar value of plastics products manufactured from all plastics raw materials amounted to approximately $1,375,000,000, SPI estimated. This figure compared with approximately one and one quarter billion dollars in 1951.

In the current year of 1953, SPI estimates that production of all plastics raw materials will approximate 2,808,000,000 lb and that the dollar value of plastics products made from all plastics raw materials will approximate $1,485,000,000.

Facilities for producing plastics products have been increased from every angle. Raw material suppliers have enlarged or built new plants to increase the production of their present materials and, in some cases, to add the production of other materials to their line. Molders, laminators, reinforced plastic processors, extruders and fabricators increased their plant capacities. Machinery manufacturers developed faster equipment with larger capacities. Only the vinyl film sheeting and coated fabrics division of the industry did not show a pronounced growth during the last year.

In the United States there are in the vicinity of 5000 plastics companies, SPI estimates, and these concerns employ in the neighborhood of 200,000 persons. Orginally concentrated in the New England and Metropolitan New York areas, this industry has been steadily moving West over the years. As a result, there are now many plastic companies in the Middle West, with a heavy concentration in the Metropolitan Chicago area and on the West Coast, with a heavy concentration in the Los Angeles and San Francisco areas.

Research is carried on continually in this field. The plastic research project at the Massachusetts Institute of Technology is now in its sixth year and the plastic pipe research project being conducted by the National Sanitation Foundation at the University of Michigan is now in its second year. Many individual companies also carry on research.

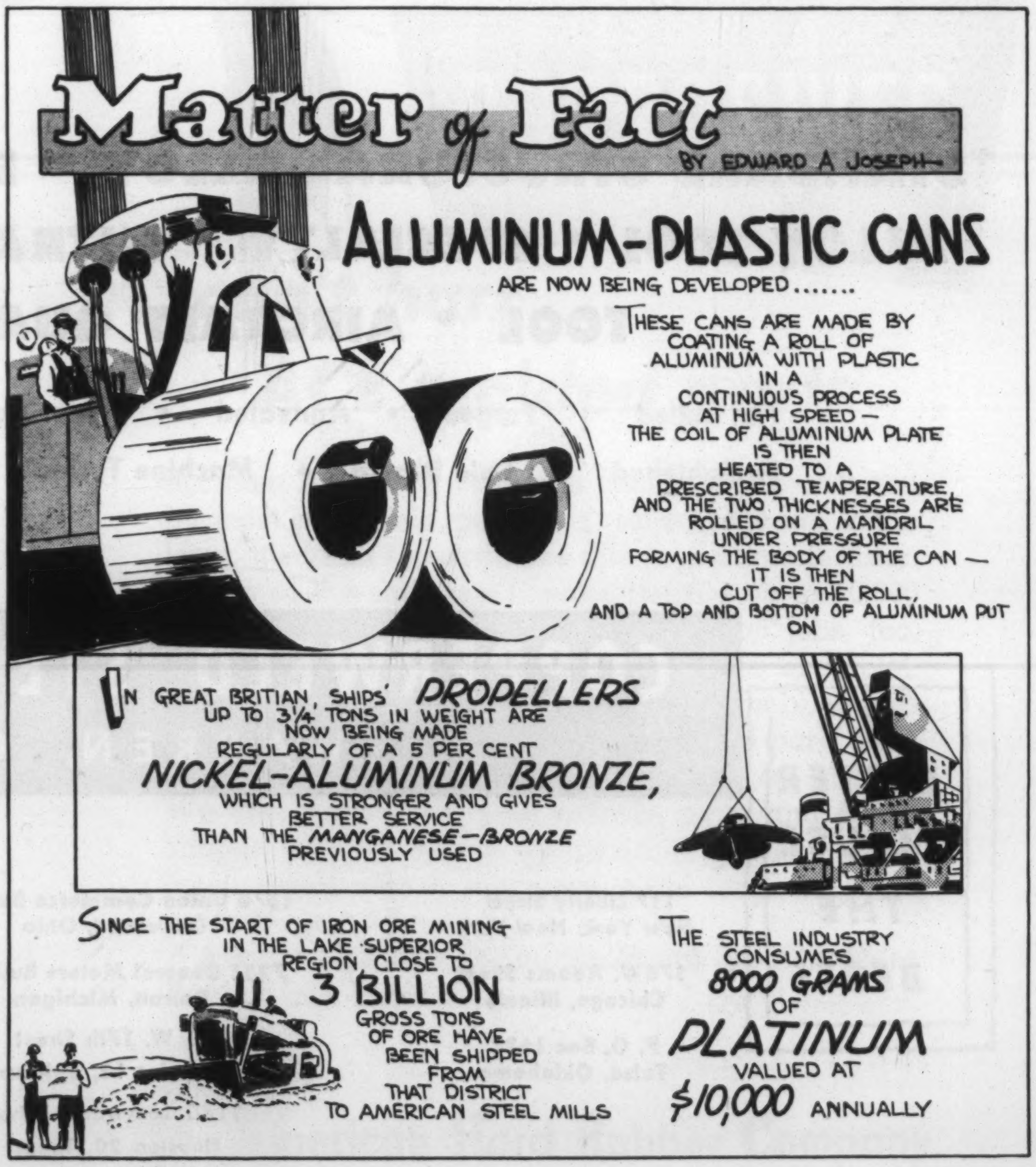
Quality standards have been prepared on melamine plastic tableware and polystyrene plastic wall tile. A third quality standard, sponsored by SPI, is nearing promulgation by the U. S. Dept. of Commerce on general purpose vinyl plastic film. Informative labeling of plastics products continues as a means of furnishing correct information as to their use, care, handling, and so forth.

One uncertainty in the long-range picture is the heavy dependency of the economy on government purchases which are scheduled to hit their peak during 1953. As far as plastics are concerned, it is estimated by SPI that 60% of all plastics production goes into industrial and military products and 40% into consumer products. The importance of these government purchases may be recognized by the fact that during the second quarter of last year such purchases stood at an annual rate of 78 billion dollars, compared with a total national product of 343 billion dollars.

Joint Industry Conference Discusses Corrosion Preventives

A number of chemical methods to prevent or retard corrosion metals were discussed during a two-day Joint Industry Conference on Preservation and Packaging, sponsored by General Motors Corp. and the R. M.

(*Continued on page* 13)


Matter of Fact
BY EDWARD A JOSEPH
ALUMINUM-PLASTIC CANS
ARE NOW BEING DEVELOPED.......
THESE CANS ARE MADE BY COATING A ROLL OF ALUMINUM WITH PLASTIC IN A CONTINUOUS PROCESS AT HIGH SPEED— THE COIL OF ALUMINUM PLATE IS THEN HEATED TO A PRESCRIBED TEMPERATURE, AND THE TWO THICKNESSES ARE ROLLED ON A MANDRIL UNDER PRESSURE FORMING THE BODY OF THE CAN— IT IS THEN CUT OFF THE ROLL, AND A TOP AND BOTTOM OF ALUMINUM PUT ON
IN GREAT BRITIAN, SHIPS' PROPELLERS UP TO 3¼ TONS IN WEIGHT ARE NOW BEING MADE REGULARLY OF A 5 PER CENT NICKEL-ALUMINUM BRONZE, WHICH IS STRONGER AND GIVES BETTER SERVICE THAN THE MANGANESE-BRONZE PREVIOUSLY USED
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News Digest

(continued from page 11)

Hollingshead Corp., in Camden, N. J., recently.

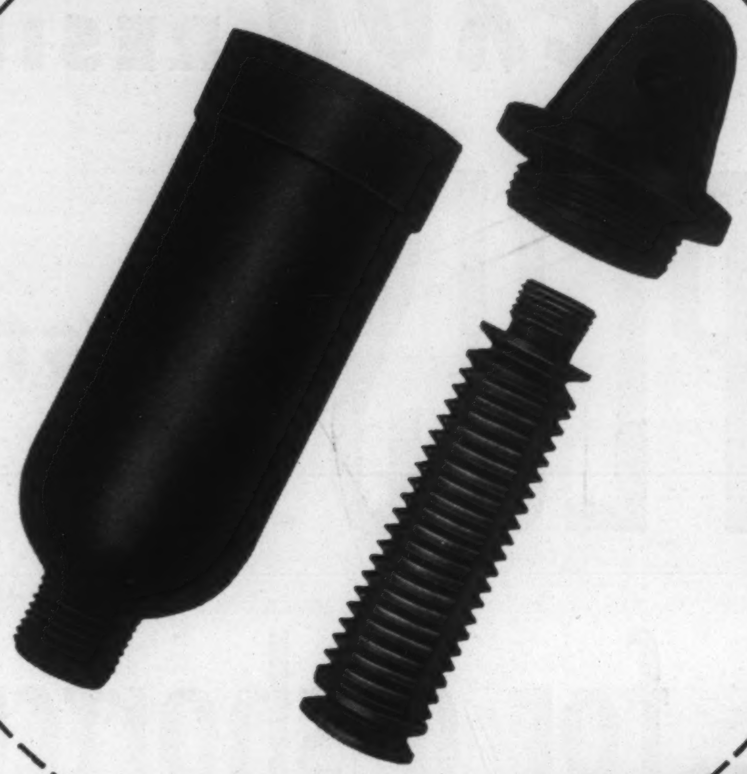
Walter Turner, packaging consultant, described the early development and experiences with peelable plastics, recounting how General Motors had saved the government between a quarter and a half million dollars during the first year of its use. Today, he noted, government approved cellulose acetate butyrate has the advantage of being water white, has greater tensile strength, greater flexibility and greater plasticity. A positive bond at the overlap is now practical and the butyrate is more stable. Plastic coating tanks have been developed with automatic dipping equipment and other material handling short cuts.

Joseph Carroll of the Naval Experimental Station in Philadelphia told how war experience pointed up the need for an engine preservative compound that would not flow off surfaces during the expected storage life of the engine. Thixotrophy (change by touch) provided the answer. Carroll told how MIL-C-5545 was developed and how the Navy has used it as a new approach to corrosion prevention.

"As more and more knowledge is gained in the field of thixotropic compounds," Carroll stated, "other applications than that to aircraft engines will no doubt become evident. We have as the basic properties the ability of the protective oil to remain in place under either hot storage conditions or extended storage conditions. This principle, when applied to engines, has proved successful. The next step is to see where else it will solve problems that have existed for us and to see where industry can use it independent of military requirements. Certainly it deserves consideration in conjunction with the canning or long term storage of military and commercial items."

M. R. Gatto, research chemist in the Research & Development Div. of Hollingshead, revealed for the first time a cold dip plastic that enables the use of strippable protective coatings without the danger and expense of heating. He demonstrated the use of a specially formulated composition— a fluid dispersion of a vinyl resin in plasticizers to which sta-

(Continued on page 172)



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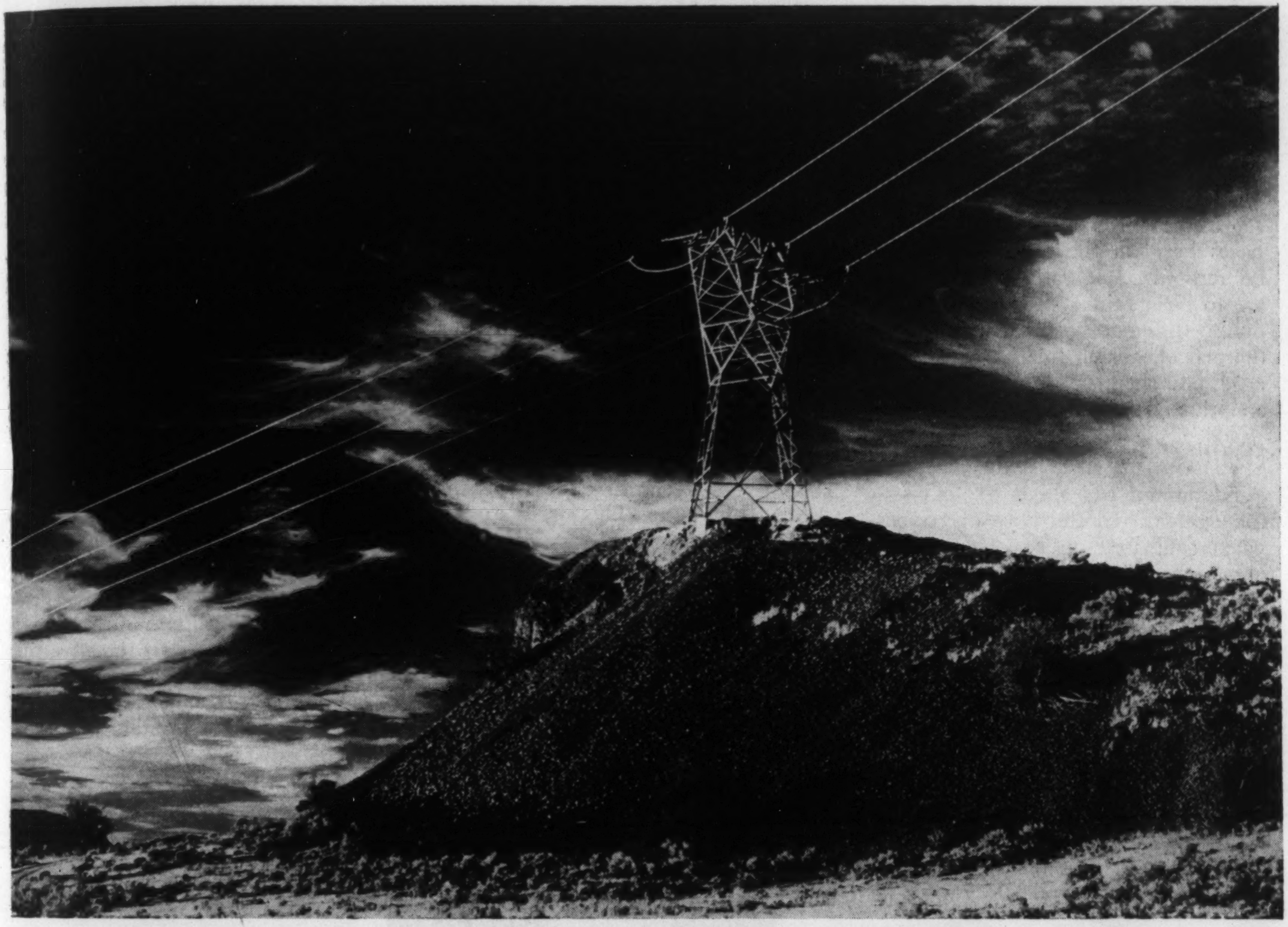
Materials & Methods
February 1953



TRANSMISSION LINES of light weight aluminum permit wider spacing of towers. (Aluminum Co. of America)

Aluminum in Electrical Applications

— Where and How It Should Be Used

by **R. M. LEEDY** and **S. A. ROSECRANS**, Westinghouse Electric Corp.

Adoption of aluminum for current and non-current carrying uses is steadily increasing. To avoid misapplications, its limitations as well as its advantages must be considered.

●THE SHORTAGE OF copper that has developed since World War II, coupled with the favorable price trend, and a more promising capacity outlook for electrical conductor (EC) grade aluminum, makes it important to examine aluminum as an alternate material for copper in electrical apparatus. Aluminum cable, usually steel reinforced, had been used for nearly 50 years in this country for overland transmission lines where the light weight of aluminum is a decided advantage, thus permitting wider spacing of towers. Aluminum bus bars dating back to 1895, as at Niagara Falls, show how long ago the value of aluminum for outdoor electrical applications was recognized. Aluminum for aircraft wiring utilizes the weight saving of the light metal, and in 1946, with copper supplies very low and the demand for building supplies high, insulated aluminum wire was introduced in this country. It had already been used for several years in Europe. Thus, existing conditions have accelerated the trend to utilize aluminum, a trend that normally would have taken years to develop.

In order to apply aluminum as a replacement for copper, the differences between the two metals must be recognized if satisfactory results are to be obtained. In the electrical field, differences in conductivity, thermal expansion, mechanical properties and chemical properties require attention.

Electrical Considerations

Aluminum has about 61 to 63% the electrical conductivity of copper when compared on a volume basis, but an EC grade aluminum conductor will weigh half as much as a copper conductor of equal resistance. However, the aluminum conductor may have approximately 1½ times the cross sectional area of a copper conductor, thus introducing space problems for some applications. Where adequate ventilation is present, and temperature rise is the limiting consideration, the increased surface of aluminum for the same resistance may allow greater electrical loading and even greater weight savings.

Thermal Expansion

Aluminum expands about 38% more than copper for equal increases in temperature and, of course, contracts similarly for decreases in temperature. Thus, apparatus which operates over a wide temperature range must be redesigned to allow for these changes if copper is to be replaced by aluminum. Similarly, in making joints between aluminum and copper conductors, differential expansion may result in loosening of the joints unless suitably designed connectors are used.

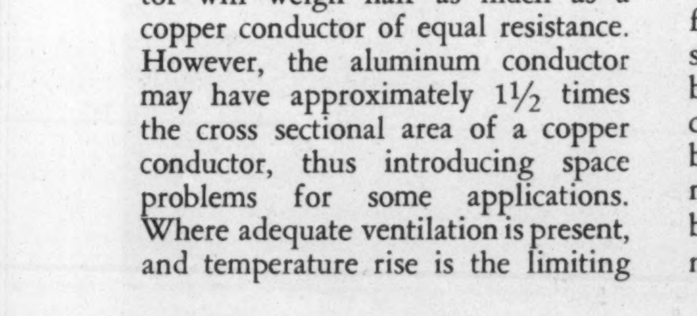
Mechanical Considerations

If a change to aluminum is being considered, strength, elongation and creep rate have to be closely studied for each case to avoid a misapplication. When conductors having cross sections resulting in equal resistance for the same length are compared for strength, hard drawn aluminum will be approximately as strong as hard copper, but annealed aluminum will be only two-thirds as strong as annealed copper. Care must, therefore, be used when working with aluminum on an application where the material may be annealed by heating to fabricating or operating temperatures. Furthermore, the annealing temperature of aluminum is lower than that of copper, and care must be exercised when enameling aluminum wire, as the temperatures required are sufficiently high to soften the metal. This increases greatly the possibility of stretching and breaking the wire when it is pulled through the enamel baking oven.

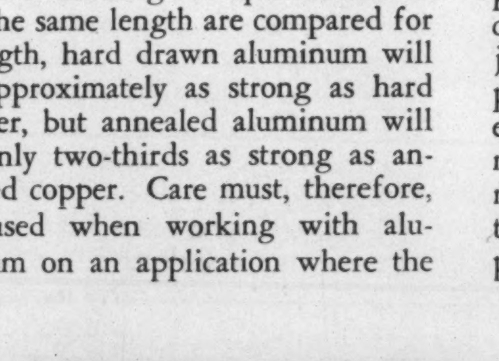
Joining

The low melting point of aluminum compared with that of copper, brings with it additional manufacturing complications, especially in such operations as brazing, soldering and burning off enamel.

Although aluminum can be joined by solderless terminals, bolted joints, soldering, brazing and welding, certain precautions must be taken to produce sound, serviceable, electrical joints. For example, one precaution is to be sure that the solderless terminals are made of aluminum, copper base alloys suitably plated, or copper-clad aluminum and that the joint is coated with a protective compound to minimize the possibility of electrolytic corrosion. Bolted joints made by conventional techniques may be satisfactory on some applications. However, there are other applications which require the use of



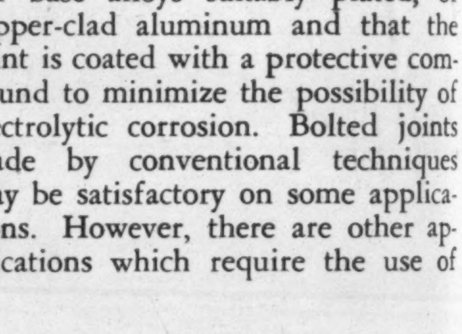
ALUMINUM BUS BARS *have been used for over 50 years in outdoor installations. (Aluminum Assn.)*



STRANDED ELECTRICAL CABLE *of aluminum produced for an overhead transmission line. This cable, over 2¼ in. in dia and consisting of 108 aluminum wires over a steel wire core, is said to be largest yet produced. (Aluminum Co. of Canada, Ltd.)*

●

INCANDESCENT LAMP BASES *of aluminum have replaced brass in many cases. (Aluminum Assn.)*



SHIELDS FOR OIL CIRCUIT BREAKERS *produced from cast aluminum to obtain smooth surfaces of large radius to reduce electrical stresses at the surface. (Aluminum Assn.)*

silver plating, joint compounds, Belleville type spring-washers, or combinations of these.

Fluxes are available for soldering, brazing and welding aluminum, but these should be used with caution as their residues may have poor dielectric strength, an adverse effect on the insulation, or be highly corrosive to the metal. Development of suitable shielded arc welding procedures facilitates the joining of aluminum to aluminum without the use of fluxes. This joining technique is so advantageous that welding will inevitably be used more extensively for joining aluminum conductors than it is for joining copper conductors.

Although aluminum can be spot or flash welded to copper, the joints become brittle if exposed to elevated temperatures for long periods of time. Thus, this procedure must be limited to applications where such conditions are not encountered or mechanical strength is unnecessary. Flash welding has been employed by some refrigeration manufacturers for aluminum-to-copper tube joints. It is also possible that this form of welding may prove practical for conductor applications where aluminum must be joined to copper.

A recent application of ultrasonics offers promise of eliminating the use of fluxes in tinning aluminum for subsequent soft soldering. At present no known technique for brazing is available that does not involve the use of a highly active fluoride bearing flux.

Corrosion

Aluminum is electropositive to copper and will be attacked if these two metals are in contact in the presence of an electrolyte. Corrosion problems may exist even in moist atmospheres. Several methods have been devised for reducing the corrosion: (1) tinning the copper, (2) using copper-clad aluminum, and (3) coating the joint with grease.

If the copper is tinned at the joint, the tin-plate acts as a buffer and the corrosion rate is reduced. By using copper-clad aluminum connectors, with the copper side connected to the copper conductor and the aluminum side to the aluminum conductor, corrosion is reduced since the exposed contact area is greatly reduced. Greases containing compounds such as zinc chromate also reduce the corrosion rates at aluminum to copper joints.

Applications

Laboratory tests, backed up by experience, indicate that aluminum can be used economically more extensively in the electrical manufacturing industry for certain apparatus. The use of aluminum bus bar on such equipment as switchgear, control panels and bus ducts will increase in the near future. In order to make this possible, it has been necessary to (1) determine the best surface preparation to assure good electrical conductivity of joints under various atmospheric and temperature conditions, (2) develop adherent coatings on a production basis where plating is desired, (3) determine the type of bolting and pressures necessary to maintain a good electrical joint, (4) establish the current carrying capacity of aluminum bus conductors under various conditions of spacing and arrangement.

Transformers and reactor windings of aluminum offer further possibilities. In general, the joining problems are similar to those mentioned in connection with bus bar applications. Calculations indicate that it may be unwise to change all types of windings in transformers to aluminum because the increased volume of aluminum necessitates, in some instances at least, an undesirable increase in the amount of core iron used. Actually, dry-type transformers that have aluminum windings have been operating successfully for several years. In the face of this, there is still a large amount of engineering development work to be done.

Properties of EC Aluminum and Copper

	EC Aluminum Annealed	Copper Annealed
Approx. Tensile Strength, Psi	12,000	34,000
Elong. at Failure, %	45	45
Specific Gravity	2.70	8.89
Allowable Current-Carrying Capacity, NEC, %	84	100
Relative Conductivity, 68 F, %	61	100
Resistivity, 68 F, Ohms/Cir Mil Ft	17.011	10.371

Although aluminum can be used in windings for motors and generators, the size of the equipment will usually have to be increased. For some few styles, this can be done economically because complete windings or certain portions of them can be changed to aluminum wire without increasing the size of the motor or generator. A considerable tonnage of copper has been conserved by the ever increasing use of aluminum die-cast rotors to replace copper windings on small induction motors. For large turbo generators, Westinghouse currently plans to continue the use of copper for rotor and stator coils, as the amount of copper per equivalent rating of machine has been materially decreased through the development of the hollow conductor design of coil.

Insulated aluminum wire for lighting and power distribution systems in office and store buildings and in factories is already being used on a limited scale. It is also possible that insulated aluminum wire will find its way into electric appliances, as tests are underway to determine the feasibility of such a change. Aluminum wire has been used for elevator control wiring in two special instances. Already in production is the aluminum base for incandescent lamp bulbs.

In addition to considering the use of aluminum as a conducting material, there are numerous instances where aluminum alloys are being used to replace copper for noncurrent carrying purposes. For example, evaporator coils, heat exchanger fins, refrigerant lines and even compressor gaskets are now being made experimentally or commercially of aluminum base alloys. Where a nonmagnetic, light-weight, or high-strength material is desired, aluminum alloy castings and wrought forms can often be advantageously employed. These are ideally suited for such items as aluminum fan blades; aluminum castings for lighting fixtures; spun aluminum reflectors for flood lights and street lights; and circuit breaker components. As new alloys are developed and existing ones improved, there will be increasing diversity of application.

Which Metal Form for Jet Engine Blades?

Characteristics of Jet Engine Blades Made by Various Methods

	Method	Production Operations[1]	Materials Applicable	Application	Tolerances	Relative Cost
Forgings	Rough Forging	Forged to approx. size and shape; machined or ground to size	Stainless steels, nonferrous alloys, certain turbine alloys	Blades, vanes, buckets	±0.040 to ±0.060 in.[3]	Cheapest[2]
	Precision Forging	Forged to final shape and size	Stainless steels, nonferrous alloys, certain turbine alloys	Blades, vanes, buckets	Thickness ±0.005 in. Contour ±0.003 in. Twist ±½ deg Straightness ±0.010 in.	10X rough forged blade
	Impact Forging (Experimental)	Forged (details not available)	—	—	—	—
Castings	Investment Casting (Lost Wax)	Cast to size, blasting or tumbling to remove traces of investment material and clean surface	Turbine alloys difficult to machine	Blades, buckets	±0.003 to ±0.010 in.	Less expensive than precision forging
	Mercast Process (Experimental)	Cast to size, followed by cleaning, as in lost wax process	Turbine alloys difficult to machine	Blades, buckets	Claimed 50% closer than lost wax	—
	Shell Molding (Experimental)	Cast in shell mold, machined or ground to size	Stainless steels	Blades, vanes	—	Lower than rough forging
Machined and Ground	Machining	Contour machining from bar stock or rough forging	Stainless steels, nonferrous alloys, certain turbine alloys	Blades, vanes, buckets	Thickness ±0.005 in. Contour ±0.003 in. Twist ±½ deg Straightness ±0.010 in.	Higher than other production methods
	Grinding	Contour grinding from bar stock or rough forging	Stainless steels, nonferrous alloys, turbine alloys	Blades, vanes, buckets	Thickness ±0.005 in. Contour ±0.003 in. Twist ±½ deg Straightness ±0.010 in.	—
Powder Metallurgy	Powder Metallurgy (Metal Powder)	Mold, sinter, coin, infiltrate with copper, precipitation hardening heat treatment	Iron powder, infiltrated with copper	Vanes	Width ±0.008 in. Thickness ±0.003 in. Contour ±0.005 in. Twist ±½ deg Straightness ±0.010 in.	Low
	Powder Metallurgy (Carbide Powder) (Experimental)	Molded under high pressure, contour machined, sintered	Carbides with binder	Blades, buckets	—	—
Fabricated Parts	Fabricating from Sheet	Bending to shape, welding trailing edge and base	Stainless steels, nonferrous alloys	Vanes	—	High
	Deep Drawing (Germany)	Series of deep draws, followed by coining	Stainless steel	Hollow vanes	—	—
	Rolling (Experimental)	Roll-formed, cut to length, base welded	Stainless steel	Blades, vanes	—	Claimed 50% cheaper than rough forging
	Extrusion (Experimental)	Hot-extruded through die, twisted while hot	Stainless steel	Blades, vanes	—	—

[1] *All blades given longitudinal finish using coated abrasives, fillet area between blade and base ground and polished.*
[2] *If machining or grinding costs included, about same as precision forged blade.*
[3] *Before finishing by machining or grinding.*

Service performance of blades, vanes and buckets influenced by production method.

by JOHN L. EVERHART, Associate Editor, Materials & Methods

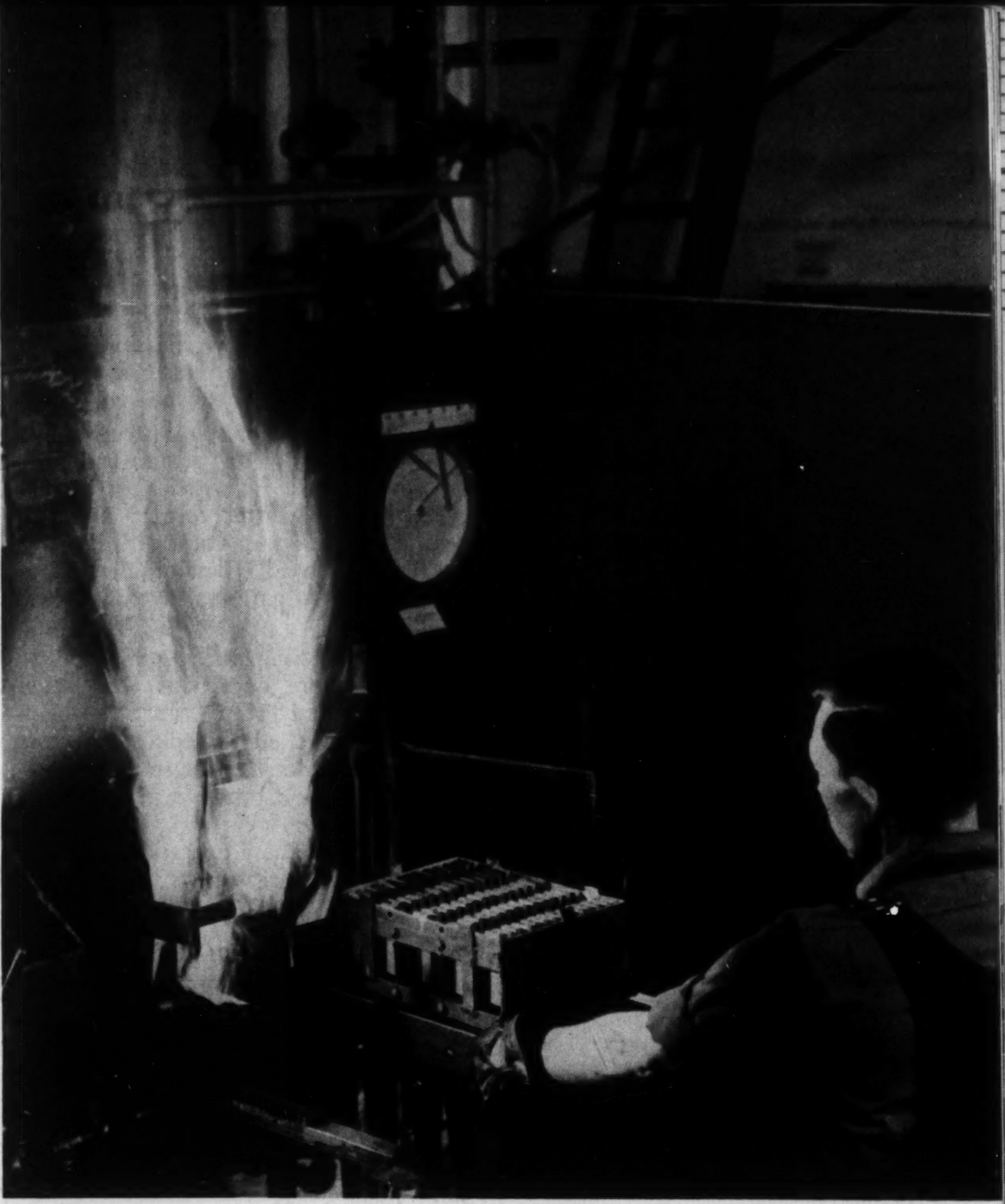
● WITH INCREASED ACTIVITY in the manufacture of jet engines, production of turbine buckets, blades and vanes becomes a major problem. A single engine may use several thousands of various shapes and sizes, in the rotor and stator, and to meet demands of the entire industry, high-speed production methods are needed. But high volume output is not the only consideration. The production method also decidedly influences the quality and service performance of its end product. Therefore, the properties and characteristics imparted to blades and buckets produced by various methods are important considerations. At present most blades both here and abroad are produced by four processes: (1) forging, (2) casting, (3) machining or grinding, and (4) powder metallurgy. In addition to these four procedures, experimental work is in progress on a number of other processes. The characteristics of blades and buckets produced by each of these methods will be covered later in some detail.

Service Requirements and Materials

The service requirements that must be met by gas turbine blades and buckets are among the most severe encountered in industry today. They must withstand high temperatures at high stresses and maintain close dimensional accuracy for satisfactory operation. Temperatures of the compressor blades may reach 650 F, while those of the turbine buckets average 1450 F and may reach 1550 F momentarily. Because of the differences in temperature between the compressor blades and the turbine buckets, material requirements are less severe for the compressor section than for the turbine section.

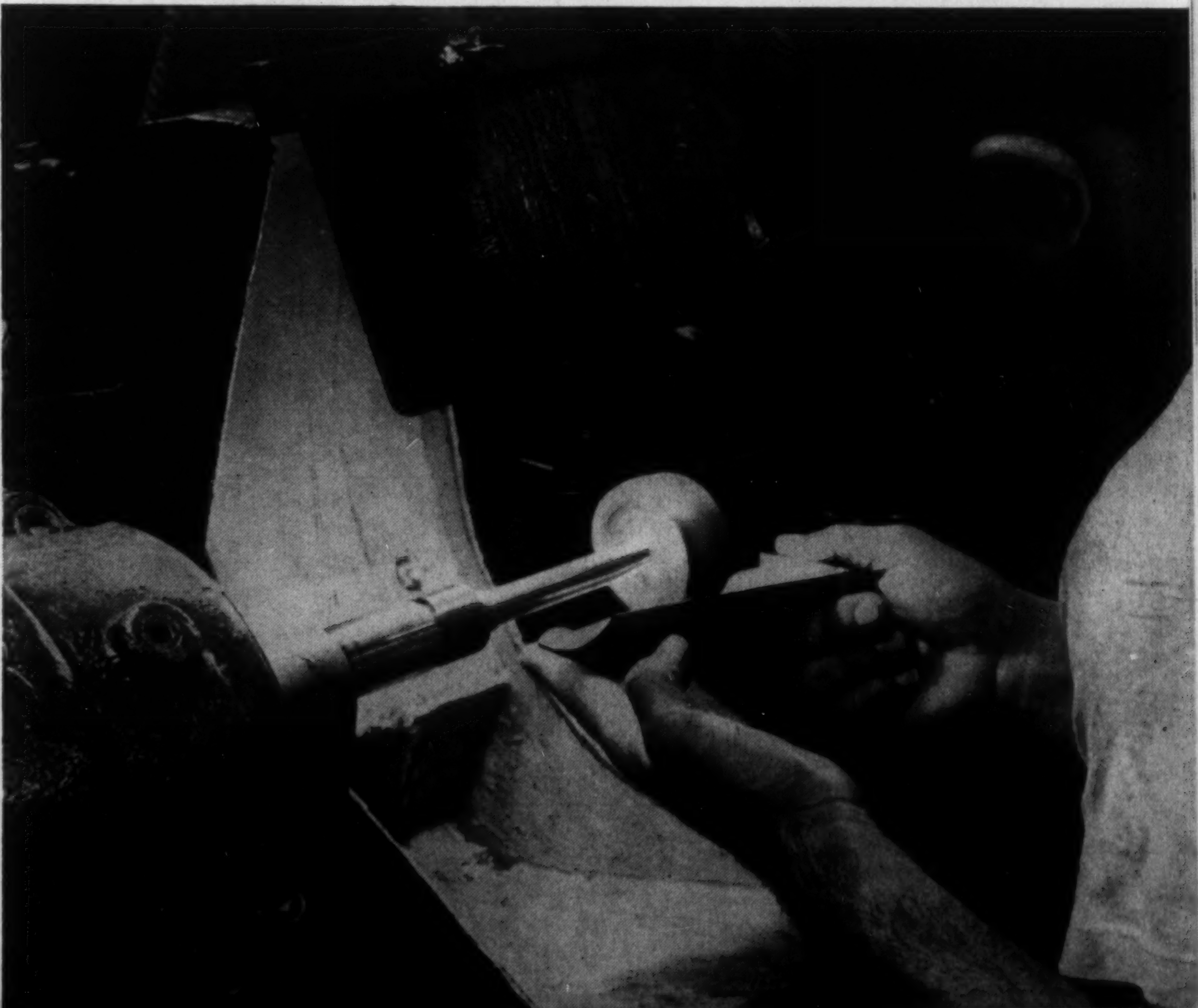
Compressor rotor blades and vanes (stator blades) need high resistance to corrosion and erosion and good creep and fatigue strengths. Since the temperatures are not particularly high, the stainless steels function satisfactorily in this section of the engine, while aluminum alloys and aluminum bronze are used in the initial compression stages of some engines.

Turbine buckets, on the other hand, must withstand the most severe combination of stress and temperature of all the engine components. They must have excellent resistance to oxidation and erosion, high creep, rupture and fatigue strengths at the



Vanes pressed from iron powder are infiltrated with copper to obtain the required strength. (Thompson Products, Inc.)

Buckets, blades and vanes are ground and polished to obtain a smooth and durable finish. (Pratt & Whitney)



operating temperatures and good resistance to thermal shock. The centrifugal stress on the turbine buckets, which depends on the speed of rotation and the density of the blade material, is higher than any other mechanical stress in the engine. With these severe requirements, few materials have been developed which have satisfactory service life. At the present stage of development, highly alloyed nickel or cobalt base alloys are used almost exclusively for turbine buckets, although work is in progress which may lead to the application of ceramic-metal mixtures and molybdenum-base alloys for this purpose.

Forgings

Blades can be produced from the stainless steels and certain of the turbine alloys either by conventional or precision forging. For the production of rough forgings, the material is cut to the required length, upset to form the root, and swaged to a suitable contour for the blade-form desired. It is then forged in a die to the proper shape and approximately 0.040 to 0.060 in. oversize. Finishing is accomplished by machining or grinding to size.

The ferritic stainless steels can be forged readily but are air-hardening and require stress-relief annealing immediately after forging. The austenitic alloys, particularly the more highly alloyed types, require greater care in forging to avoid internal bursts.

The precision forging of blades requires more operations than rough forging and greater care. The blank is either rolled to reduce the cross-section with the exception of the root area and to increase the length, or upset to form the root. Following one of these operations, any surface defects are removed by grinding. The blank is forged to size in a series of operations. Light blows must be struck in the early stages of reduction to avoid damage to the part but heavier blows can be struck as the blade becomes thinner. In the production of thin blades, only one blow can be struck without reheating because of rapid loss of heat and, therefore, many reheatings may be required.

It has been reported by some authorities that the accuracy obtained in precision forging equals that produced in machining. Others disagree, stating that the thickness tolerance must be greater and ordinarily there is some misalignment between the upper and lower surfaces which contributes to poor leading and trailing edges. The cost has been estimated to be ten times that of a rough forged blade, although the total cost of the latter, if machining charges are included, will approach that of the precision forged blade.

Precision forging is a fairly rapid method of production but requires heavy equipment and die costs are high. It is not applicable to small output but is essentially a mass production operation. Precision forging is used in production of buckets, blades and vanes.

Jet turbine buckets of stainless steel have been produced by a new forging method in which forging is accomplished between two opposed impellers moving horizontally, which meet for a fraction of a second. Only two blows are required and the operation is automatic. The operation is still in the experimental stages.

In Europe, hollow blades have been produced by forging also. Heptagonal-shaped bar stock was cut to length, drilled and swaged over a mandrel. Blades were mass-produced

Strength-Density Ratio of Some Ceramics and Ceramals at 1800 F (Ault and Deutsch)*

Material	Strength, Psi	Density, G/Ml	Strength-Density Ratio at 1800 F Compared with High Temperature Alloy
80% Titanium Carbide—20% Cobalt	34,600	5.38	1.60
64% Boron Carbide—38% Iron	16,200[1]	3.30	1.22
95% Titanium Carbide—5% Tungsten	25,000[1]	5.19	1.20
90% Titanium Carbide—10% Molybdenum	23,800[1]	5.10	1.14
Titanium Carbide	17,000	4.74	0.90
Boron Carbide	22,500	2.5	2.25
High Temperature Alloy	33,000	8.31	1.00

[1] *Values calculated from elevated temperature bending strength.*
* *SAE Quarterly Trans., Vol. 14, July 1950, p. 398.*

Stress-Rupture Properties of Some Turbine Alloys (Allen)*

Material	Composition, %										Stress Psi for Rupture in 100 hr at		
	C	Cr	Ni	Co	Mo	W	Cb	Ti	Fe	Others	1200 F	1500 F	1800 F
19-9 DL	0.3	19	9	—	2	1.2	0.3	—	67	—	40,000	13,000	—
16-25-561	0.15	16	25	—	6	—	—	—	51	N 0.18	50,000	13,800	—
N 155	0.3	20	20	20	3	2	1	—	32	N 0.11	55,000	18,800	4900
Refractalloy 26	0.04	18	37	20	3	—	—	3	18	Al 0.3	74,000	26,500	—
S 590	0.4	21	20	20	4	4	4	—	25	—	—	20,000	—
S 816	0.4	20	20	44	4	4	4	—	3	—	62,000	24,200	5300
Inconel X (Cb)	0.05	15	73	—	—	—	1	2.5	7	—	58,000	29,000	—
Hastalloy B	0.12	0.27	64	—	29	—	—	—	5	—	56,000	16,800	—
Nimonic 80	0.05	21	75	—	—	—	—	2.5	0.7	Al 0.6	49,000	17,200	—
Vitallium	0.2	28	2.5	62	5.5	—	—	—	1	—	52,000	21,500	9300
61	0.4	24	1	67	—	5	—	—	1	—	51,500	28,000	8600

* *Steel, Vol. 119, Aug. 27, 1951, p. 72.*

in this manner for a German engine but approximately 90% of the raw stock was removed during the production of the blade, making this method an expensive and wasteful procedure.

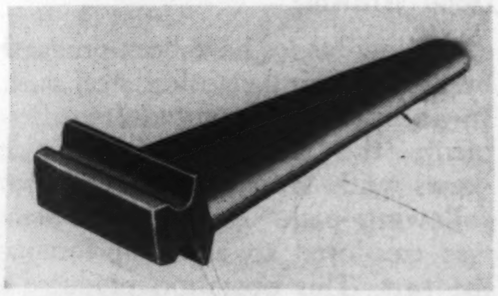
Castings

For those highly alloyed turbine blade alloys which cannot be forged, casting is employed. The major production in this field has been by investment casting using the lost wax process. However, frozen mercury patterns and the shell molding process have also been used, although little information has been released on them.

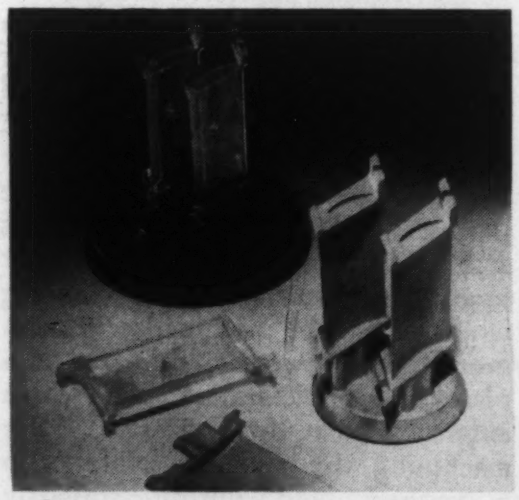
In the lost wax process a master pattern is used to prepare a wax replica of the blade. This wax pattern is coated with a precoat of the investment material and then backed with a mixture of the same material to form the mold. The mold is warmed sufficiently to melt the wax, which is then removed by gravity or suction methods, leaving a cavity of the required shape. The mold is heated to about 1600 to 2000 F to drive out retained moisture and burn out residual wax and can then be used immediately for production of the casting. Turbine alloys are cast into molds, which are held in this high temperature range to secure good flow and complete filling of the cavity. After casting, the investment material is broken from the blades and sprues are removed.

In the lost wax process, tolerances considered commercially practical by one manufacturer are ±0.003 to 0.010 in. per in. Finishing generally involves blasting or tumbling to remove traces of the investment material and clean the surface. All cast parts receive radiographic inspection for defects. Blades and buckets are in production from a number of alloys which are difficult to machine. Both solid and hollow shapes have been produced, and the process is reported to be less expensive than precision forging.

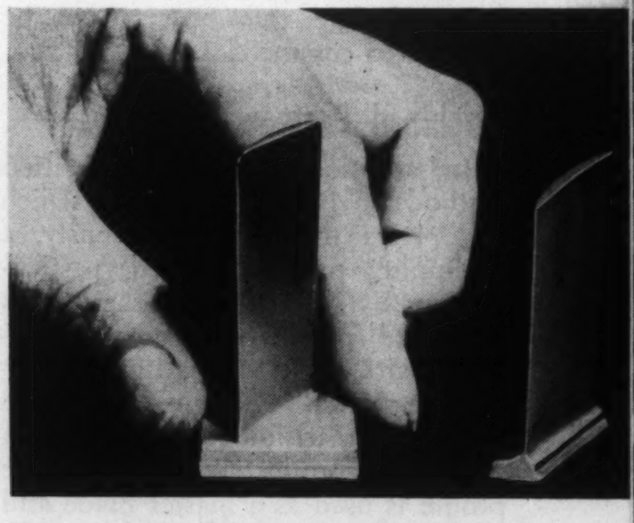
The Mercast process is a method of investment casting which uses frozen mercury patterns. Mercury is poured into the desired master mold and frozen. After removal, the solid mercury pattern is dipped repeatedly into a suitable ceramic material to obtain a coating 1/8 to 1/4 in. thick. The coated mercury pattern is dried and allowed to heat to room temperature, thus melting the mercury which is poured out of the mold cavity. After removal of the mercury, the mold is usually backed with sand, heated to harden the ceramic material, and the metal is poured immediately.



Titanium carbide blades offer possibilities for the future operation of engines at higher temperatures than can be employed successfully with present blading materials. (Kennametal, Inc.)



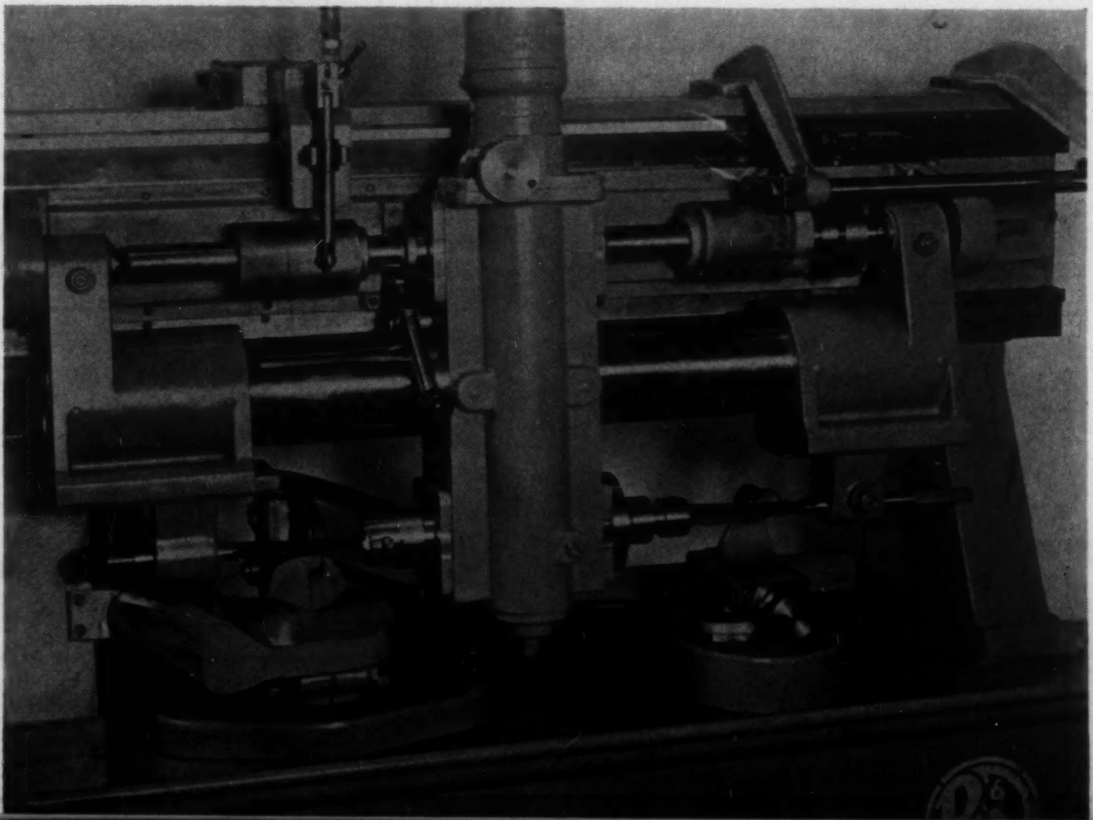
Investment casting is used in the production of buckets and blades from high temperature turbine alloys. (Precision Metalsmith, Inc.)



Vanes fabricated from strip (left) have been approved for use in stator elements. At the right is a forged vane. (General Electric Co.)

Precision forged compressor blade produced from pre-form obtained by upsetting. (Utica Drop Forge & Tool Co.)

Profile grinder removes 0.05 to 0.06 in. of stock from rough forgings to meet dimensional tolerances, at production rates up to 20 per min. (Behr-Manning)



The surface finish of the mold prepared in this manner is said to be excellent, and it is claimed that parts can be held to tolerances 50% closer than are possible with the lost wax process. The major advantage of the mercury process is the fact that mercury will weld on contact, which simplifies the production of complicated shapes. To offset this advantage, however, is the fact that mercury amalgamates with brass, aluminum and soft metal dies and, therefore, steel dies must be used.

Under development is the production of molds by the shell molding process. In this procedure molds are prepared by coating a metal pattern with a thin plastics-bonded sand mixture which is hardened by heat and stripped from the pattern. Finishing involves overall grinding and polishing. Blades made by shell molding have been tested but did not have satisfactory properties, and additional development will be required before this process can be considered commercial.

Machined Parts

In addition to the combination methods involving machining which have been mentioned previously, a machining process is used, particularly in Europe, in which the part is machined from bar stock. It is applicable particularly to small output unless the section is designed to require minimum machining. Generally an enlarged reproduction of the blade profile is used as a master blade and a single-point tool follows the contour and produces the blade. The root is usually machined first and the final operations consist of shaping the blade. A modification of the process combines a series of milling and grinding steps to produce the blade. Machining yields accurate and readily reproducible parts, but it is generally considered that machined blades are more expensive than those produced by other commercial methods.

Powder Metallurgy Parts

Blades are produced from iron powder which is molded into form under relatively low pressure, sintered and coined to obtain the desired contour. Following the coining operation the blades are infiltrated with copper, straightened and given a precipitation hardening heat treatment. Blades are produced in two lengths and after hardening are cut to the desired length and the root is formed by machining.

The process has several advantages. Since small presses and light loads are employed in forming the blade, standard tool steel dies are used. Such dies have a life of 75,000 to 250,000 pieces. Production is rapid and costs are relatively low. The major disadvantage lies in the limitation in blade shape which can be produced. The strength of the blades is not considered to be high enough for their application as rotor blades and they have been used only in stator elements.

A somewhat modified powder metallurgy process is used for the production of titanium carbide blades. The only present producer mixes titanium carbide powder with small additions of tantalum and columbium carbides and adds about 30% nickel. The desired quantity of this mixture is placed in a pressure vessel, together with an explosive charge, and the vessel is filled with liquid. When the charge is fired, a pressure of 20,000 to 50,000 psi develops and compresses the carbide blanks. The blanks as removed from the chamber have a consistency like chalk, but the hardness of the carbides introduces a machining problem much like that involved in cutting a soft grinding wheel. They are machined with diamond cutting wheels, using a template, to a predetermined size which is greater than the final size. After machining, the blades are sintered in a vacuum, and during sintering shrink to the final size. This method of production is still experimental but offers posibilities as a procedure for producing blades which can be operated at higher temperatures than can be used with the present blading materials. However, the material is brittle and new fastening methods must be developed if it is to be used.

Grinding

Grinding is used in the manufacture of both forged and cast jet blades in various stages of production and all are given a longitudinal finish using coated abrasives, while the fillet area between the blade and the base, or platform, is ground and polished using shaped grinding wheels or abrasive belts. In addition, a combination of rough forging and contour grinding is employed to replace precision forging. A number of machines are available which produce the required contours at rapid rates of production. As an example, Nimonic 80 has not been successfully precision forged to the required dimensions and present practice calls for rough forging followed by grinding to obtain the tolerances required.

Fabricated from Sheet

Fabrication from sheet has been employed for the production of hollow blades. The sheet is cut to length and can be bent over a mandrel. The blade is finished by welding the trailing edge and attaching the root section, also by welding. The method has the advantage that only light press equipment is necessary and, after the development of suitable progressive dies, the operations can be performed by moderately skilled labor. There is little waste and rapid rates of production are possible. Blades fabricated in this fashion have been used in the stator elements only.

Deep Drawing

Hollow blades have been produced by deep drawing stainless steel sheet. In an operation reported from Germany, the process required nine draws with an annealing operation following each. A special lubricant was employed to assist in forming the part. This operation produced a tube tapered from one end to the other, which was then formed into the blade in 27 additional operations and finished by grinding.

Rolling

This procedure which has been applied to the forming of stainless steels is similar to that used in the roll forming of knife blades. The blades are formed in long strips, cut to length, and a suitable base which forms the root is welded to the blade to complete the job. Parts produced in this fashion have been used in stator assemblies but have not been employed for rotors. The process is reported to reduce waste by 40% by eliminating machining costs and to cut the costs per blade roughly in half.

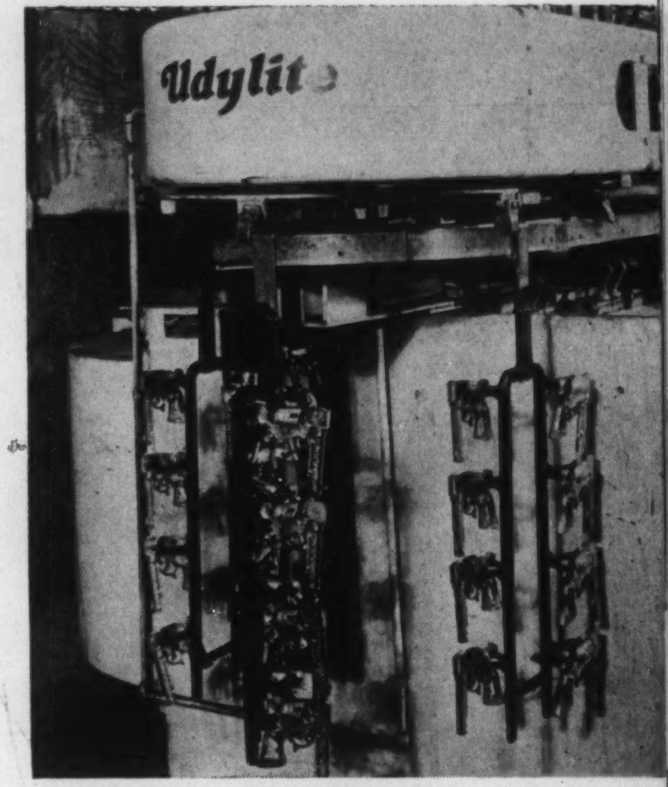
Extrusion

The Ugine-Sejournet process of hot extrusion is under investigation also for the production of blades. In this process stainless steel, coated with glass to act as a lubricant, is forced through a die to obtain the desired contour. The required twist is formed while the blade is still hot.

A Critical Look at White Brass Plated Coatings

- ***What are its advantages and limitations?***
- ***Will it replace nickel permanently in some applications?***

by **DR. R. B. SALTONSTALL,** Technical Director, The Udylite Corp.



For the plating of zinc-base die castings, white brass has a distinct advantage over nickel because it eliminates the problem of contamination of the plating solution.

● GOVERNMENTAL RESTRICTIONS on both end-uses and quantity of nickel for electrodepositing protective and decorative coatings have caused a somewhat frenzied search for alternate coatings. While authorities agree generally that no completely satisfactory alternates have been brought to light, a bright zinc-copper alloy plating process which produces a coating containing 75 to 90% zinc is being marketed by several suppliers, and has enjoyed considerable acceptance by the plating industry.

As might be expected in an emergency, overly optomistic predictions were made on the applicability of this deposit. The purpose of this article is to examine the present status of this interesting development, separating as much as possible the facts from the influence of promotional activities.

From the standpoint of operation, alloy plating processes usually present more serious problems than those used for depositing a single metal. Surprisingly few serious operational difficulties have been experienced in producing uniformly bright white brass coatings on a variety of formed metal articles, although careful control is necessary. The deposit can be chromium plated readily and, when this has been accomplished, it is practically impossible to distinguish it visually from chromium plated bright nickel.

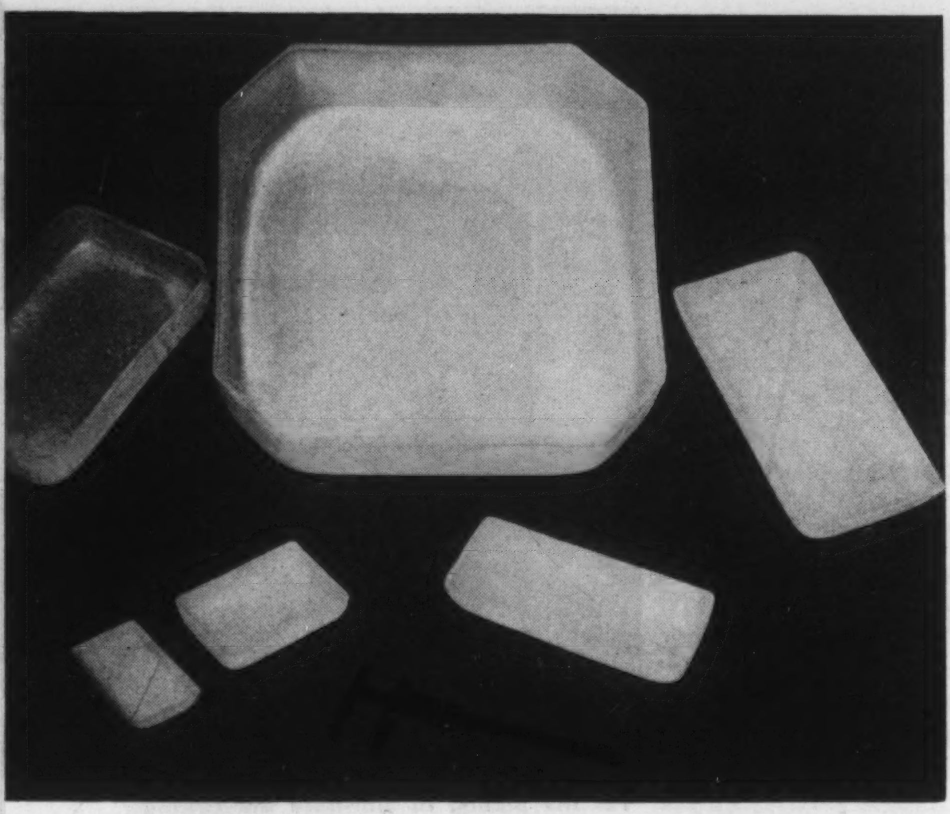
Appearance is, however, only one requirement of a satisfactory electrodeposit. Permanence of appearance and other physical properties may be of even greater importance and in some of these respects, bright white brass leaves something to be desired. The deposit is rather highly stressed, and is quite brittle. Because of this, it is not practical to deposit coatings having a thickness much in excess of 0.0003 in. Unfortunately, chromium plating aggravates the stressed condition of the deposit in proportion to the thickness of chromium plate, and it is, therefore, not practical to deposit a heavy chromium which might otherwise increase durability.

Because of these limitations, plus the fact that white corrosion products characteristic of zinc appear in a few weeks when exposed to weathering, bright white brass is not suitable for outdoor exposure unless further protected by a durable clear synthetic coating. Since the more durable synthetics are made so by baking, and since elevated temperatures accelerate stress cracking of chromium plated white brass, such a procedure is not particularly feasible.

However, for mild exposure, such as interior automotive hardware, novelty items and household goods not exposed to moisture, high humidity or corrosive vapors, the deposit appears to be reasonably satisfactory. Early in the nickel shortage, many items in the prohibited lists of NPA Orders M-14 and M-80 were plated with white brass and chromium, and to a large extent these uses are continuing.

Since September 1952, when Order M-80 was amended to permit a thin flash (0.00005 in.) of nickel as an undercoat for chromium on items in prohibited Lists A and B, there has been a rather sharp decrease in new installations of bright white brass. While this thin flash of nickel is of little protective value, the relaxation of the order was apparently interpreted by many as a harbinger of imminent further relaxation, and there is little doubt but that bright nickel (in thickness considerably in excess of 0.00005 in.) is still preferred to white brass for most applications. Further relaxation of the nickel order has not been forthcoming, and some hint has been given that the nickel supply situation, at least with regard to electroplating on civilian goods, may get much worse before it gets better. In this event, further increase in the use of bright white brass may be expected.

In a few applications, bright white brass has shown more advantages than disadvantages when compared with bright nickel. One of these (shown in the accompanying illustration) is the plating of zinc base die-cast toy pistols. The contamination of a bright nickel solution with zinc from the unprotected internal surfaces of these castings presented a problem which is nonexistent in white brass. Other toys and items, such as tools, casket hardware and novelties, may be continuing uses for bright white brass independent of the nickel situation.



CALCINING AND EVAPORATING TRAYS of fused quartz readily withstand temperatures up to 2200 F and conditions of extreme thermal shock.

FURNACE MUFFLES. These are three of the commonly used shapes.

Fused Quartz—A Versatile Industrial Material

by **F. E. WRIGHT**, Amersil Co., Inc.

Unusual thermal, chemical and electrical properties suit fused quartz for extreme service conditions which cannot be met by most other materials.

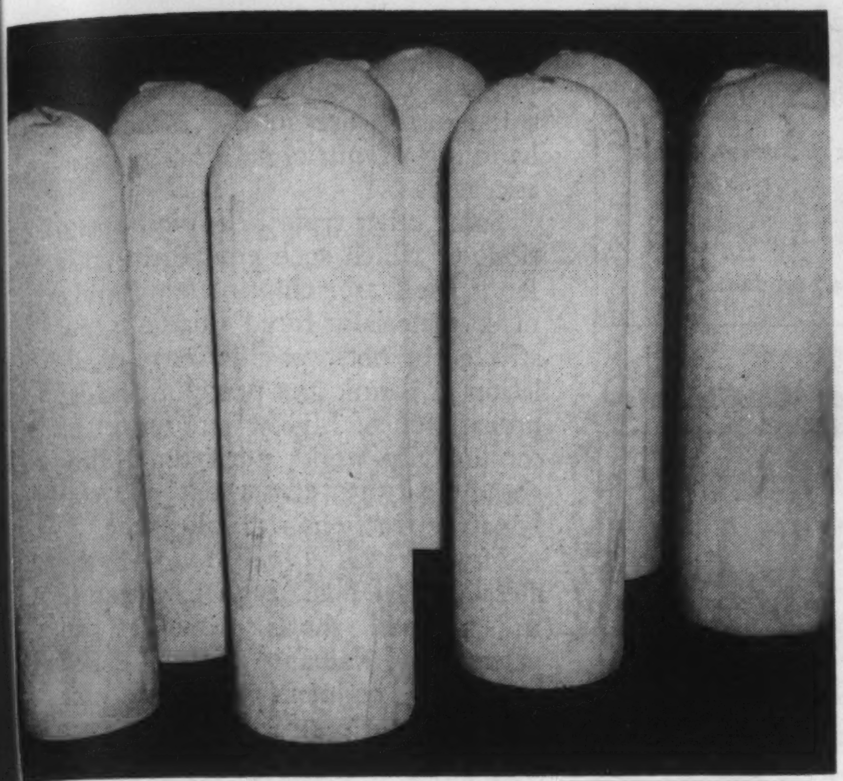
● AS THE MAJOR CONSTITUENT of glass, quartz (or silica) has a long and familiar history, but by itself pure or "fused" quartz is an industrial material whose properties and uses are still unfamiliar to many engineers, designers and production men. It is over 100 years ago that it was first successfully produced in the laboratory, but for many years fused quartz remained little more than a scientific curiosity. Only in recent years has it won recognition in the industrial world as a versatile material with important applications in the chemical, metallurgical and electrical fields. Today more fused quartz is being produced than ever before. Fused quartz equipment is finding new applications in modern industry almost daily.

Nature of Fused Quartz

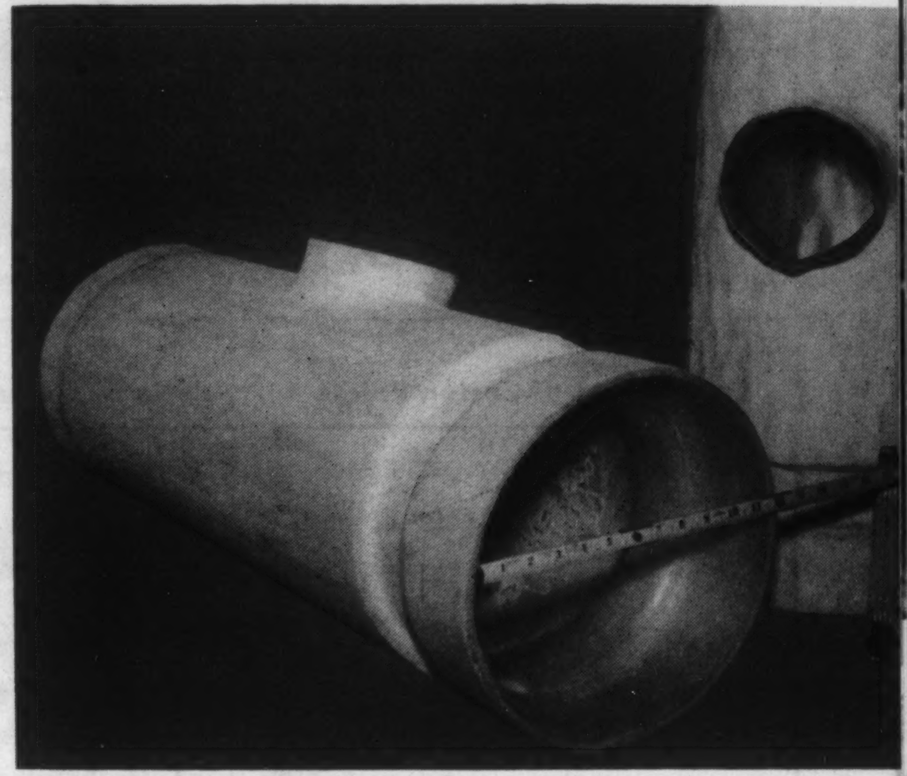
A number of different terms have been applied to the material here called "fused quartz"—silica glass, quartz glass, vitreous silica, vitreous quartz, among others. This multiplication of terms can be misleading for in actuality they all refer to the same basic material, which viewed mineralogically is fused quartz, or viewed chemically is fused silica.

Fused quartz is distinctly different from glass, for the two materials differ markedly in their chemical structure. That of fused quartz is simple, for nothing is ever added to it. Furthermore, its properties are such that it can be put to a range of uses for which glass is completely unsuited.

Fused quartz is a pure, noncrystalline, homogeneous material that is 99.8% silicon oxide. It is produced either from pure silica sand or from Brazilian rock crystal. From the



EVACUATION CHAMBERS. These fused quartz tubes serve as a nonconductor liner and vacuum chamber in induction furnaces. They are about 15 in. in dia by 48 in. tall.



ACID COOLER MANIFOLD SECTIONS are used as part of the equipment in the manufacture of chemically pure acids.

former is produced an opaque or translucent variety, the opaqueness deriving from the presence of numerous small bubbles. From the latter comes a transparent variety.

Needless confusion often arises when industrial users fail to distinguish between the two varieties—opaque and transparent—in making inquiry about, or ordering, fused quartz equipment. This discussion is limited to a consideration of opaque fused quartz, the type more commonly encountered in industrial applications.

The earliest method of fusing quartz was the oxyhydric blowpipe, being based on the high temperatures of the oxyhydrogen flame. It was not until the introduction and perfection of the electric resistance furnace method that the production of fused quartz on a commercial scale became feasible.

The problem of fusing pure quartz and keeping it pure is not an easy one. Its softening point or working temperature is about 3040 F (that of lead glass being about 1155 F). At this temperature, it is literally acidic in its reactions. The usual refractory materials, such as magnesia or alumina, cannnot be used in production because the corresponding silicates would be formed. The problem has been solved by making the raw material itself the container.

For practical purposes, the electric resistance furnace may be visualized as a pile of silica sand, having at opposite sides two electrodes with a resistor between them. Although the sand may be contained in a steel box, no "melt" ever comes in contact with the metal. As the current flows and heat is produced, the resistor becomes surrounded by a plastic, somewhat viscous mass of fused silica, around which, in turn, is a protective layer of unfused sand. The fused mass, sausage-like in form, is lifted from the bed of sand and very rapidly worked into its final shape by blowing or pressing.

Properties of Fused Quartz

An ususual combination of thermal, chemical and electrical properties makes fused quartz the material of choice for many industrial processes involving extreme conditions that cannot be met by most other materials. Among the properties which recommend this material are: (1) resistance to high temperature; (2) resistance to thermal shock; (3) low coefficient of thermal expansion; (4) resistance to corrosion; and (5) high electrical insulating value.

Fused quartz can be used indefinitely at temperatures up to 1830 F. It can also be used successfully up to about 2190 F, although its life may be shortened by devitrification which sets in at 1920 F. An accompanying table compares fused quartz with other materials with respect to heat resistance.

Fused quartz is remarkably impervious to thermal shock. Small pieces can be brought to white heat and then plunged into water without damage. Even large vessels and pipes are not affected by thermal shock. Breakage from thermal shock is thus ordinarily not a problem with such equipment. However, where complicating conditions exist, it is usually best to seek the manufacturer's recommendations. The indifference to thermal shock stems from fused quartz' low coefficient of thermal expansion. It is virtually negligible as revealed by a comparison of it with the coefficients of expansion of other materials (see table).

Among high-temperature materials, fused quartz is outstanding in being nonporous and chemically inert. It is thus immune to corrosive attack by most liquids and gases. Especially noteworthy is its acid resistance. Neither organic nor inorganic acids have any effect on it. Exceptions are hydrofluoric acid at all temperatures and phosphoric acid at elevated temperatures. It should be pointed out, however, that fused quartz is less affected by phosphoric acid than are ceramic materials and glass. Nor does it react with hydrofluoric acid to the same degree as do most kinds of glass. As for alkaline solutions,

Electrical Characteristics of Fused Quartz

Dielectric Constant	At 100,000 cycles, 77 F and 60% humidity—4.4.
Insulation	A thickness of one millimeter is absolute insulation against 10,000 volts.
Dielectric Strength	410 volts per mil at 122 F.
Dielectric Power Loss	0.97, or ⅛ that of wet process porcelain.

Comparison of Fusion Points

Platinum	3225 F
Fused Quartz	3193 F
Porcelain	2822 F
Iron	2795 F
Glass	2012 F
Copper	1837 F
Aluminum	1215 F

Ratio of Expansion Coefficients

Fused Quartz	1
Carbon	2
Pyrex Glass	6
Porcelain	6
Tungsten	9
Hard Glass	10
Tantalum	11
Flint Glass	14
Graphite	14
Plate and Crown Glass	16
Platinum	17
Cast Iron	18
Copper	34

they attack fused quartz only slighly at room temperatures, their effect becoming more rapid and pronounced at higher temperatures.

Also uncommon is the combination of fused quartz' thermal qualities with its excellent electrical insulating properties. Its electrical resistivity and dielectric strength are high, while its dielectric losses are low (see table).

Other interesting properties of this material are its ability to hold a high vacuum; its light weight, great strength under compression; ease in handling and installing.

Applications

Chemical Applications — In the modern chemical industry, fused quartz equipment has a wide range of uses, notable in calcining and acid manufacture. For example, in the calcining of fluorescent powders and various metallic oxides, fused quartz vessels amply fulfill the dual requirement of this process. They readily withstand temperatures up to 2190 F, while their corrosion resistance preserves the powders from contaminating impurities.

The inert, noncontaminiating quality of fused quartz equipment is vitally important in the manufacture of chemically pure acids for medical and biological laboratory work. Its tolerance of high heats and of a rapid rate of cooling makes it highly suitable for use in the making or handling of nitric, sulfuric or muriatic acids.

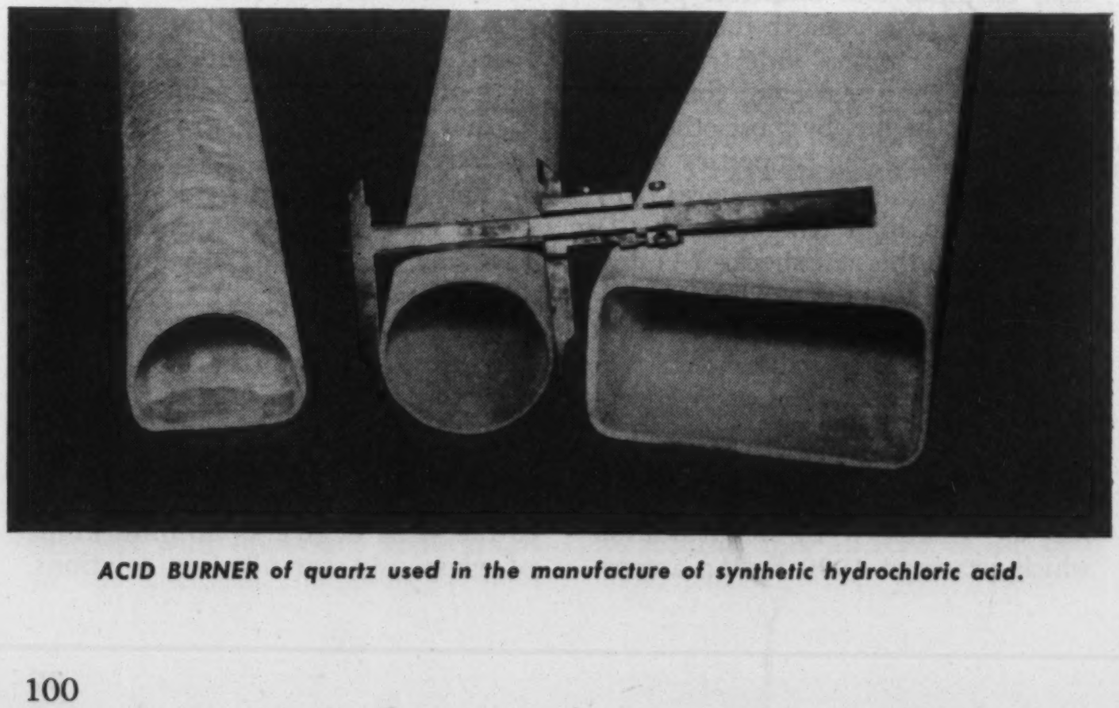
Some other typical chemical operations to which such equipment aptly lends itself are: chlorination (unlike most materials, fused quartz is not affected by hot, wet chlorine); distillation of formic and perchloric acids; preparation of highly pure water for conductivity work; purifying hydrogen or nitrogen from oxygen; carbonating reactions with phosgene.

Metallurgical Applications—In the metallurgical field, high temperature and thermal shock properties are particularly valuable. Thus, fused quartz is eminently practical for thermocouple protection tubes where dipping into molten metal for temperature reading is necessary. In high temperature furnace muffles, it has proved to be an economical material because of its ability to transmit radiant energy. As an excellent nonconductor, it is used in induction furnace liners, as well as for evacuation chambers in induction heating.

Fused quartz tubes and other equipment are being increasingly employed in the heat treating of various ores and metals in electric, gas or oil furnaces. Other metallurgical applications include combustion tubes for laboratory analyses of metals and vessels for the study of metals in the vapor phase.

Electrical Applications — As an insulator for high voltage currents, fused quartz shows a clear superiority to such materials as porcelain, glass and mica. At high temperatures where glass ceases to be an insulator, or under thermal shock, where ceramics also lose their insulating power, fused quartz remains serviceable. And in electrical research work, it is valuable, due to its much slower loss of insulating value at increasing temperatures.

Kinds of Fused Quartz Equipment—The most common kinds of equipment include tubing, pipes, pots, storage vessels, multi-shaped muffles and trays, used either for pilot plant or production purposes. However, the technique of fabrication is such that it can be adapted to the production of almost any shape or size of vessel or container. Thus, it is possible to "tailor-make" any kind of fused quartz equipment to fit the specific requirements of the process in which it is to be used.



***ACID BURNER** of quartz used in the manufacture of synthetic hydrochloric acid.*

Zirconium Now Fabricated by Powder Metallurgy Methods

by **HERBERT S. KALISH,**
Section Head, Atomic Energy Div.,
Sylvania Electric Products, Inc.

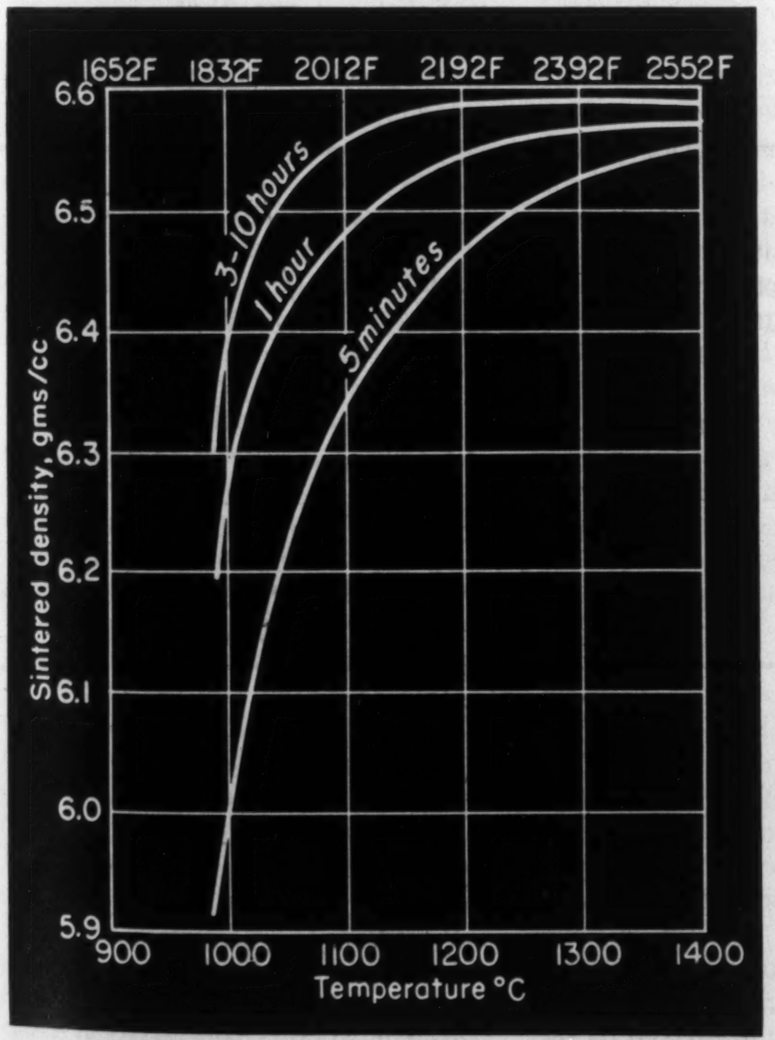
Sintered zirconium (1) is readily cold worked, (2) reduces machining costs, (3) minimizes scrap loss, and (4) simplifies alloying.

● THE MELTING OF zirconium, although well advanced, is still a difficult process requiring high temperatures and very special techniques. Lack of a suitable crucible material has created a "fast" arc-melting technique which does not permit alloying additions to be made readily. Alloying in the powder metallurgy of zirconium is the simple process of tumble mixing the addition powder with zirconium (or zirconium hydride) powder prior to compacting. Zirconium parts fabricated by the powder metallurgy method avoid many of the difficulties of melting, and subsequent hot working techniques reduce machining costs to a minimum and prevents costly scrap losses.

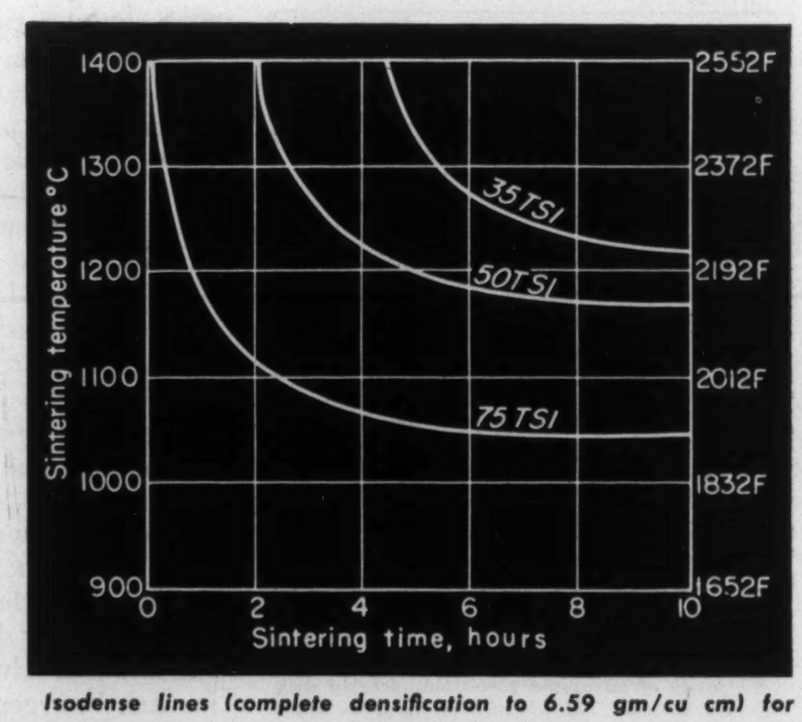
Zirconium Powders

Zirconium can absorb up to 10 weight % oxygen or 5 weight % nitrogen at high temperature and retain it all in solid solution at room temperature. As little as 0.5 weight % of either of these gases will make the metal quite brittle. Since zirconium picks up oxygen very readily when it is being pulverized, to make ductile zirconium powder, a reduction process must be used to obtain powder directly, or the pure metal must be rendered brittle and pulverized without serious increase in the oxygen or nitrogen content.

Probably the best available method for making suitable zirconium powder for compacting and sintering is



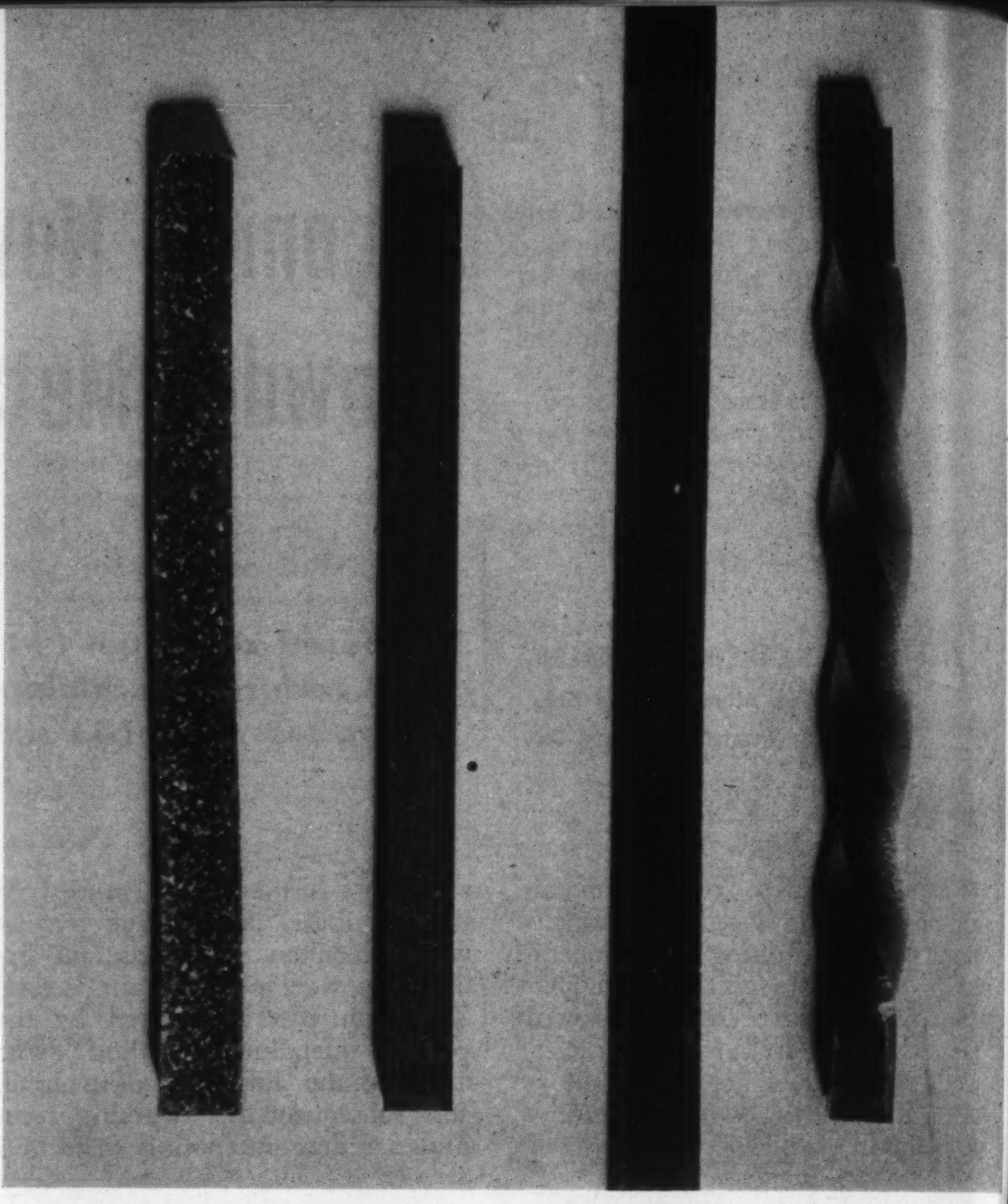
Effect of time and temperature on the density of vacuum-sintered zirconium produced from −325 mesh zirconium hydride by compacting at 50 tis.



Isodense lines (complete densification to 6.59 gm/cu cm) for −325 mesh zirconium hydride compacted as indicated and vacuum sintered.

the hydride process. In general, some residual hydrogen is present in zirconium from both major refining methods, although the quantity is too small to render the zirconium brittle enough for grinding. Zirconium is readily embrittled, however, by heating it in purified hydrogen. For a spongy metal of large surface area like sponge from the Kroll process, the reaction proceeds rapidly at 750 F, but where rather massive material is being hydrided, such as Van Arkel zirconium crystal bar, the diffusion of hydrogen is too slow at this temperature and it is more expedient to hydride at 1470 F.

Massive hydride material can thus be produced without any important increase in oxygen or nitrogen content. This hydrided zirconium is very brittle and can be pulverized automatically in a hammer mill or by hand. Automatic grinding must be carried out in an inert atmosphere of argon or helium. These powders are extremely pyrophoric when too fine, and must be handled with caution. If, however, the powder is ground to the correct particle size for optimum powder metallurgy purposes, all –325 mesh with an average particle size of about 8 microns, there need be very little fines below 2 microns and this powder will not ignite spontaneously. In handling zirconium powder, whether it is hydride or pure metal, every safeguard must be taken to prevent hazards to workers from fire or explosion. This is especially true where the "ordinarily safe" powders are handled such as the one referred to.



Ductile zirconium produced from powder. Left to right: as sintered, surface ground, cold reduced 50% in thickness, twisted through 360 deg.

Properties of Zirconium Compacts

Density	6.59* g/cm^3
Resistivity	58–60 microhm-cm at 68 F
Hardness	92 Rockwell B
Tensile Strength	95,000 psi 91,000 psi†
Yield Strength, 0.2% Offset	77,300 psi 73,000 psi†
Reduction in Area, %	6.1 33.5†
Elongation, %	5.3 22†
Cold Reduction in Thickness Before the First Sign of Edge Cracking, %	50–75

As-sintered metal made from –325 mesh zirconium hydride powder compacted at 50 tsi and sintered 3 hr at 2280 F in vacuum.

** Density of zirconium varies considerably with hafnium content. This density is for a hafnium content of about 2.5 weight %. The density of pure zirconium is reported as 6.50.*

† Hot-rolled at 1300 F, 50% red.

This hydride powder, when compacted and sintered, will yield the ductile metal shown in an accompanying illustration. The quality of the sintered product depends largely upon the zirconium metal used to make the powder. It has been shown that sintered zirconium can be produced without any increase in impurities except oxygen. The oxygen increase occurs while grinding the massive hydride to a powder. Thus, the zirconium hydride powder ground to –325 mesh will contain about 0.2 to 0.3 weight % oxygen. After compacting and sintering, the oxygen content remains essentially the same.

This oxygen which remains in solid solution after sintering, increases the hardness and tensile strength of the zirconium but does not materially affect either the cold or hot working properties or the ductility of the metal. In addition, it is unlikely that the corrosion resistance or any other desirable property of zirconium is adversely affected by the increased oxygen content. The homogeneous, controlled addition of oxygen by sintering turns out, in fact, to be beneficial, since oxygen is one of the most desirable alloying elements for strengthening the metal.

For certain applications zirconium powder instead of the hydride powder may be required. For these applications hydride powder is readily decomposed to zirconium powder at 1470 F in a vacuum of 5 x 10^{-5} mm of Hg or better. The resultant loosely sintered cake must be recomminuted. In general, there are no advantages to the zironium powder, however. It does compact to a better green strength, as shown in a table, but the hydride powder compact has adequate green strength for normal handling after being compacted at as little as 15 tsi. The use of the hydride powder reduces processing costs considerably and permits higher purity to be obtained. The hydride also densifies during sintering far more readily than zirconium metal powder.

The Sintered Parts

The zirconium or zirconium hydride powder is compacted at from 15 to 100 tsi without lubricants to prevent difficulty during vacuum sintering. The compacts are vacuum

Green Strength of Compacted –200 Mesh Zirconium and Zirconium Hydride Powders

Powder Type	Modulus of Rupture, Psi for Compacts Pressed at: 30 Tsi	70 Tsi
Zirconium Hydride	870	2520
Mixture of 50% Zirconium and 50% Zirconium Hydride	1030	3920
Zirconium	1840	5360

sintered, preferably in a high-purity graphite boat, although a zirconium oxide boat can be used. Sintering temperature and time depends upon the required density and the compacting pressure used. Optimum sintering conditions to obtain dense zirconium from –325 mesh zirconium hydride powder compacted at 50 tsi are 3 hr at 2280 F. The temperature and time needed to sinter compacts, pressed at various pressures, to full density, are shown in a graph. The density that will be obtained as a function of sintering time and temperature for compacts pressed at 50 tsi is indicated also in a graph. From these two graphs one can predict how to sinter compacted zirconium hydride to any needed density.

It is remarkable that this metal, when sintered from the compacted hydride 1470 F below the melting point of zirconium, can yield theoretical density. Although zirconium powder requires about 200 F more temperature than zirconium hydride it also sinters with unusual ease.

The as-sintered bars when removed from the furnace have perfectly bright metallic surfaces. It is possible to utilize this metal without subsequent fabrication. If fabrication is desired the metal can be machined or surface ground, although the latter requires care and preferably should be done wet. Zirconium machines and grinds about the same as aluminum. Powder metallurgy zirconium can be hot-worked readily in air up to 1300 F if a little surface oxidation can be tolerated. For prolonged hot working it is advisable to jacket the sample in steel or copper.

The properties of sintered zirconium are shown in a table. It is a relatively high strength and high ductility material of considerable potential use. The ductility as shown by reduction in area and elongation can be markedly improved by hot working or cold working and annealing. Several hundred samples of zirconium made by these methods have been cold rolled from 50 to 75% reduction in thickness without edge cracking. Zirconium powder metallurgy parts have been cold rolled to 75% reduction in thickness, annealed at 1650 F and rolled another 75%. Cold reduction with proper intermediate anneals would, therefore, permit almost unlimited cold forming of this powder metallurgy product. As a further indication of the ductility of the sintered zirconium, a typical sintered bar is shown in a photograph after it was twisted through more than 360 deg.

Zirconium has a future in the chemical industry, in nuclear reactors, in the vacuum tube industry, and no doubt many other applications will unfold as the metal becomes less expensive and more readily available. Where machining costs are to be reduced, where scrap is to be utilized and minimized, and where alloying is to be readily accomplished, the use of sintered zirconium can play an important role.

References

W. J. Kroll, A. W. Schlecten and L. A. Yerkes, "Ductile Zirconium from Zircon Sand," *Trans. Electrochemical Society*, 1946, Vol. 89, pp 263-276.

R. S. Dean, J. R. Long, F. S. Wartman and E. L. Anderson, "Preparation and Properties of Ductile Titanium," *Trans. AIME*, 1946, Vol. 166, pp 369-381.

R. S. Dean, J. R. Long, F. S. Wartman and E. T. Hayes, "Ductile Titanium—Its Fabrication and Physical Properties," *Trans. AIME*, 1946, Vol. 166, pp 382-398.

H. H. Hausner and H. S. Kalish, "A Preliminary Investigation of the Zirconium-Beryllium System by Powder Metallurgy Methods," *Trans. AIME*, 1950, Vol. 180, p 59.

E. A. Gulbransen and K. E. Andrews, "Kinetics of the Reactions of Zirconium with O_2, N_2 and H_2," *Trans. AIME*, 1949, Vol. 185, p 515.

J. D. Fast, *Metallwirtschaft*, 1938, Vol. 17, p 641.

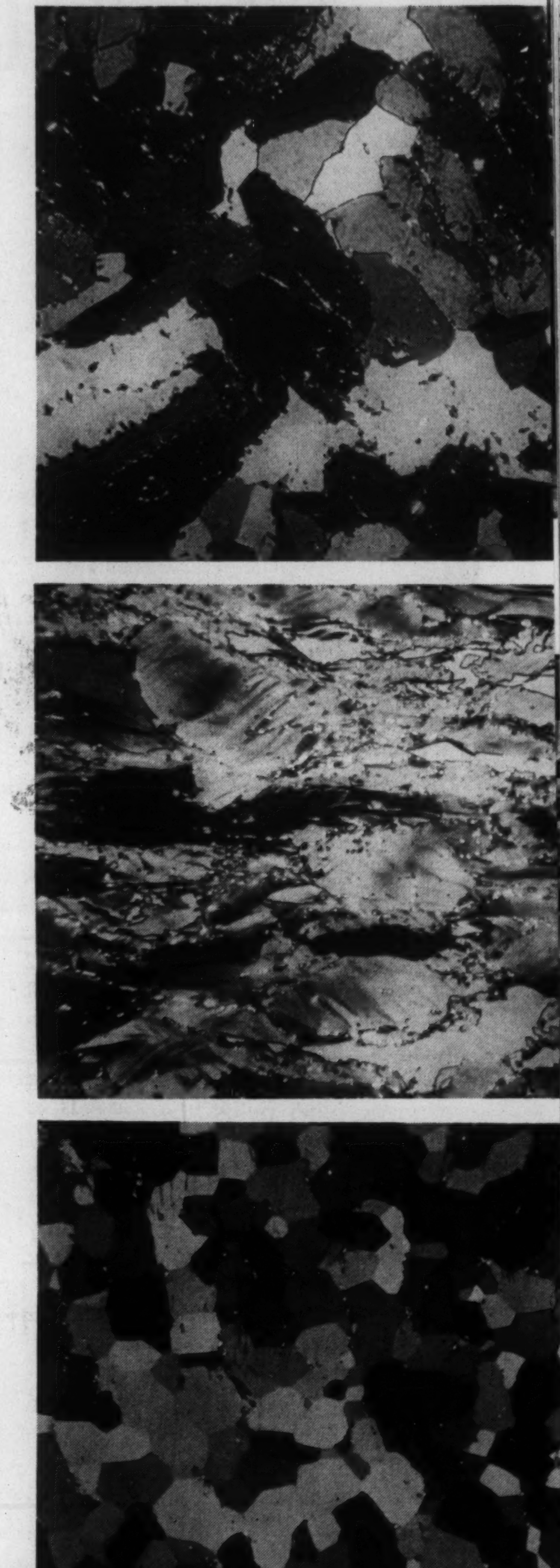
D. Lely and L. Hamburger, "The Production of the Elements Thorium, Uranium, Zirconium and Titanium," *Ztsch. Anorg. Allgem. Chem.*, 1914, Vol. 87, p 209.

W. C. Lilliendahl and H. C. Rentschler, "Recent Developments on the Preparation of Zirconium," *Trans. Electrochemical Soc.*, 1947, Vol. 91, pp 237-246.

H. H. Hausner, H. S. Kalish and R. P. Angier, "Powder Metallurgy of Zirconium," *Trans. AIME*, 1951, Vol. 191, pp 625-633.

H. S. Kalish, H. H. Hausner and R. P. Angier, "The Physical Properties of Sintered Zirconium," Sept. 1944, Mar. 30, 1951, Technical Information Service, Oak Ridge, Tenn.

H. H. Hausner, "The Formation of Metal from Its Compound During Sintering," *Powder Metallurgy Bulletin*, Vol. 6, No. 1, Apr., 1951, p 41.



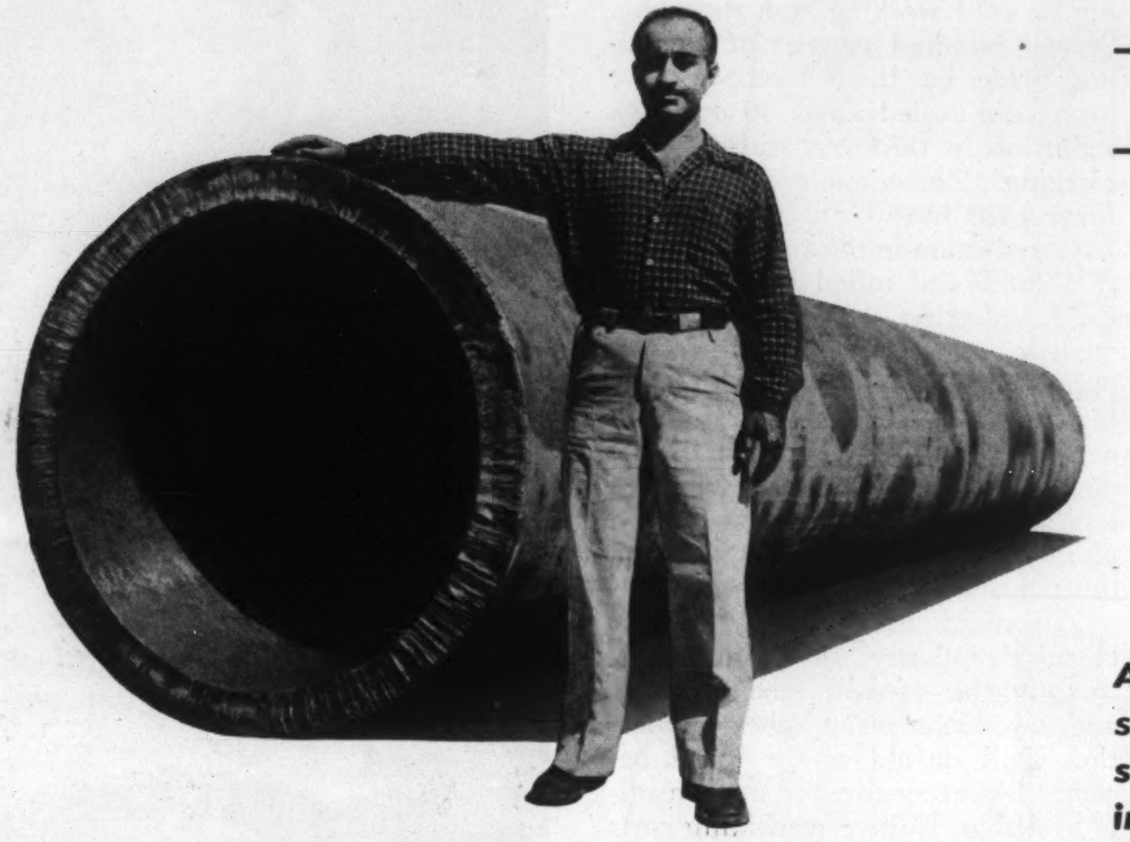
Microstructure of cold-worked and annealed zirconium after compacting from –325 mesh zirconium hydride powder and sintering from 3 hr at 2300 F. (a) As sintered, (b) cold-rolled, 75% reduction, longitudinal section, (c) annealed 1 hr at 1650 F after cold-rolling. Polarized light 200X mag.

Centrifugally Cast Steel Tubing

—What It Has to Offer
—Where It Can Be Used

by T. E. RYBKA,

Engineer, Peter A. Frasse and Co., Inc.



LARGE SIZE TUBES, up to about 50 in. O.D., as well as small sizes, down to 2 in. O.D., can be made by centrifugal casting.

Available in a wide range of sizes and a variety of compositions, centrifugally cast tubing has nondirectional properties and good soundness and ductility.

● CENTRIFUGAL CAST steel tubing is a relatively new product that is ideally suited for the production of many high-quality engineering parts. As in so many other fields, the recent war provided impetus to further development and expanded use of this product. Today the economic and physical soundness of centrifugally cast tubing has been proven by many and varied uses.

Centrifugally cast tubing should not be confused with statically cast tubing. The centrifugally cast product is superior in its ductility and its freedom from unsoundness, such as porosity, subsurface seams and inclusions. It is practically free from segregation, is lower in cost, and can be produced to closer tolerances. Of special significance are its nondirectional properties. Thus, equal tensile strengths are obtained in both transverse and longitudinal directions.

Compositions, Sizes, Properties

Centrifugally cast tubing is available in sizes ranging from a minimum of approximately 2 in. O.D. to a maximum of 50 in. O.D. Wall thicknesses range from ¼ to 4 in. and lengths up to 16 ft. In addition to circular cross sections, the external surface can be supplied with special shapes, including elliptical, hexagonal or fluted. The bore, of necessity, is always round. Where sufficient quantities are required, these shapes may prove very economical.

Centrifugally cast tubes produced in horizontal molds permit the selection of alloys not otherwise obtainable. Tubing of special analysis can be obtained in quantities as low as 300 lb. Materials available run the gamut of the ferrous metals, from gray iron and alloy cast irons, through the carbon steels of from 0.05 to 0.90%, alloy steels, and both corrosion and heat resistant stainless steels. The accompanying table shows some of the steels commonly used for centrifugally cast tubes and the properties to be expected.

Considerable economy will be realized where tubes in the higher alloy grades may be required, or where heavy wall tubing with good physical properties is needed. It should be noted that centrifugally cast steel tubing in the smaller diameters and in the usual carbon steel grades is not competitive price-wise with mechanical tubing of normal thickness. Generally speaking, centrifugally cast tubes enjoy a price advantage over statically cast tubes.

One of the principal difficulties encountered in static casting is the occurrence of voids and porosity caused by shrinkage which accompanies the transition from liquid to solid. Although the use of risers and feeding heads help to alleviate this condition, the steel foundry must pour twice as much metal in the average mold as that required for the finished static casting. In centrifugal casting the metal is forced against the mold wall under high pressures resulting from centrifugal force imparted by the rotating mold. The force generated is approximately 75 times gravity and is sufficient to sustain the molten metal on the wall of the mold, precluding the use of a core and resulting in a concentric tube with greatly reduced foundry costs.

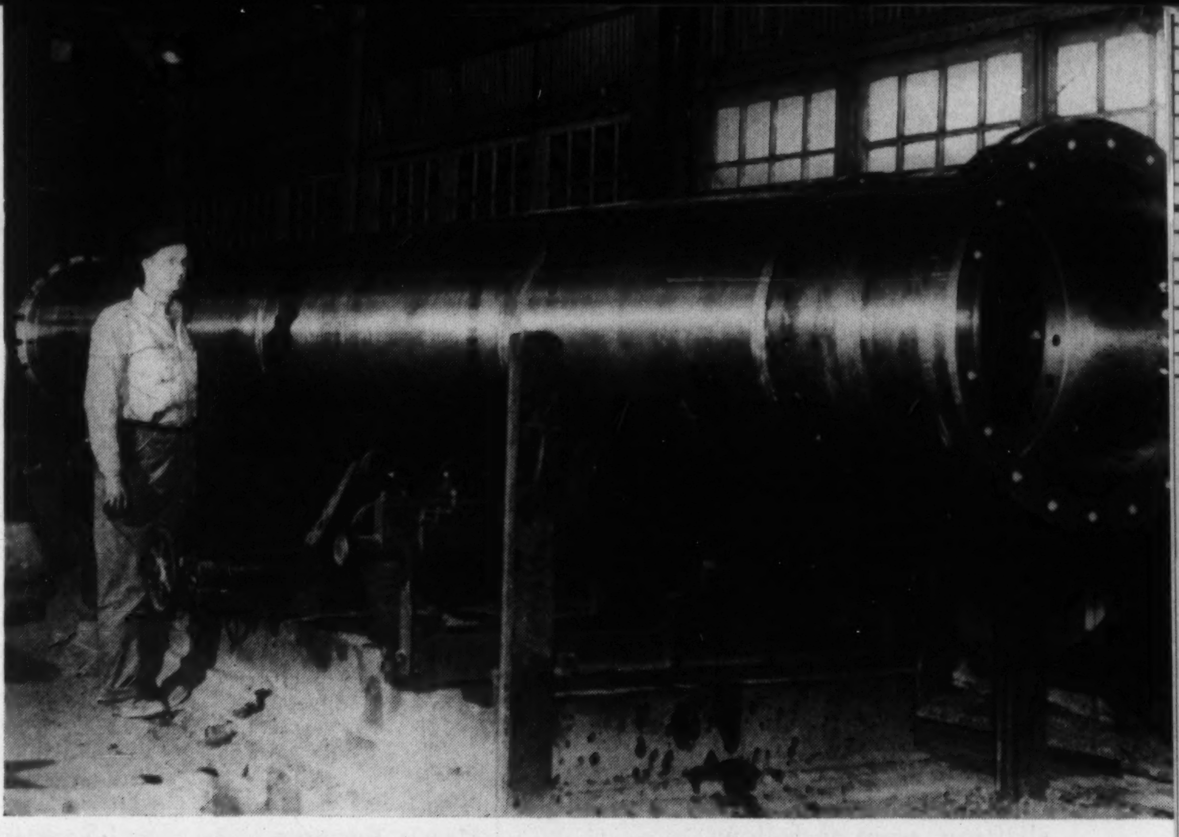
When the casting is spun, impurities such as dirt, sand and slag, having lower specific gravity, are forced to the inside surface by centrifugal force. Any gas or air pockets are likewise eliminated. The elimination of these foreign inclusions results in a sounder casting and the product is more uniform. A centrifugal casting is denser than a static casting. Upon cooling, solidification is directional and takes place from the outside toward the center, thus helping to drive defects to the inside surface, where they are readily removed.

As compared to rolled steel, centrifugally cast steel does not show directional properties. That is, the properties in the transverse direction are not significantly different from those in the longitudinal direction. Standard cast steel specifications are preferred in ordering centrifugal castings; however, the accompanying table and photograph show that a centrifugally cast steel tube meets the ASTM requirements for rolled seamless tubing. Note that the transverse tests on the centrifugal tube are equal to the longitudinal tests although the elongation requirement for seamless tubing is considerably lower. Another table and photograph show the results of tests conducted on centrifugally cast 25-20 stainless steel tubing.

Applications

Centrifugally cast steel tubing finds extensive applications in replacing parts formerly made by forging. Tests made at Ford Motor Co. (E. C. Jeter, *SAE Journal*, Vol. 53, Jan. 1945) comparing centrifugally cast with forged aircraft cylinder barrels showed not only better economy for the centrifugal castings, but actually higher resistance to internal hydrostatic pressure. The forging tended to split directionally along flow lines, while the nondirectional properties of the casting allowed significantly higher pressure carrying ability. It was found by Ford that the same routine inspection was applicable to centrifugal cast and forged cylinder barrels. Over 900,000 of these cast aircraft cylinder barrels went into successful service.

The fact that gates and risers are not required greatly increases the yield, and in such cases as ship shafts, printing rolls, etc., 100% yield is obtained. In castings such as radial-engine cylinder barrels where the inside machined surface is highly important, the wall is poured thicker than required. This extra thickness on the inside serves very much as an inside gate or feeder and is later removed by machining. In such cases, the yield is somewhat lower. The centrifugal method is highly adaptable for mass production of identical castings.



STAINLESS STEEL RETORT *fabricated of 25 chromium—20% nickel centrifugally cast components.*

CYLINDER BARRELS *for radial engines centrifugally cast using AMS 5345 chromium-molybdenum steel.*

One of the difficulties encountered in the shipbuilding program of 1940 was the procurement of propulsion shafting. This ship shafting had been a high-quality forged product of high physical properties, but because of the enormous demands on the forge shops a new source had to be found. The Bureau of Ships settled on shafting fabricated by welding flanges onto a centrifugally cast center section.

Watertown Arsenal, where gun barrels had been centrifugally cast for a number of years, supplied a 90-mm gun casting from which a mine sweeper shaft was produced. When tests demonstrated the potential of this method of producing shafting, a commercial source with production engineering ability had to be located, and it was found that the American Cast Iron Pipe Co. had the necessary facilities to produce the castings.

Hollow ship shafting for destroyer-escort vessels, tug boats, coast guard cutters and cargo vessels were also made with centrifugally cast tubes. When considering that shafting is part of the main propulsion machinery system, it is realized that very careful consideration had to be given and important advantages had to be gained before modifications were adopted. The tubing had the following chemical analysis: carbon, 0.35 max; manganese, 1.10 max; phosphorus, 0.05 max; sulfur, 0.05% max. Mechanical properties, determined by specimens cut from the shafting, were as follows:

Ultimate tensile strength	90,000 psi max
Yield point	40,000 psi min
Elongation in 2 in.	15% min
Reduction in area	30% min
Bend Test	120 min

This use shows the practicability of centrifugally cast tubing for highly stressed applications such as propulsion shafting. As a result of the Navy ship shafting success, the American Bureau of Shipping approved a specification for this type of shafting in ships coming under its jurisdiction.

An interesting application for large diameter stainless steel tubes is a retort for chemical service. In this instance, the designer considered two alternatives in the fabrication of these units: (1) by the use of rolled and welded plates to make up the cylindrical body section with end pieces to be forgings or castings; or (2) the use of centrifugally cast alloy steel tubes for the body section, with statically cast alloy steel end portions welded to each end.

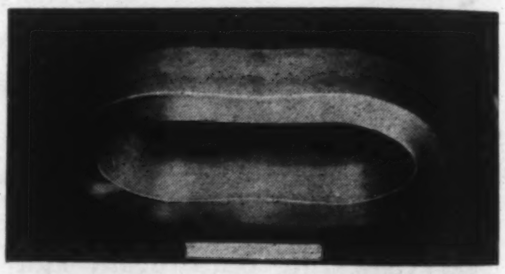
Test of Centrifugally Cast Carbon Steel Tubing

	ASTM A106 Gr. B Specification (Rolled Seamless Tubing)	Tests of a Centrifugally Cast Tubing*
Chemical Composition, %	C, 0.30 Max Mn, 0.35 to 1.00 P, 0.04 max S, 0.06 max Si, 0.10 min	0.16 0.51 0.026 0.029 0.46
Flattening Test	Machined O.D. Thickness Length of specimen 2½ in. min Distance between plates 7.1 in. max at 1st crack (H)	10½ in. 1.25 in. 4 in. 5.95 in. (Small tear at I.D.)
Tensile, Longitudinal	T.S.—60,000 psi min Y.P.—35,000 psi min El.—22% min R.A.	67,150 38,050 22.4 32.3
Tensile, Transverse	T.S.—60,000 psi min Y.P.—35,000 psi min El.—12% min R.A.	68,300 40,350 23.6 31.8

* *Cast 11 in. O.D. by 7 in. I.D.—normalized & tempered.*

A decision was made to have entirely cast and fabricated assemblies. The acid electric furnance steel used was Type AISI 310 Modified. Test bars taken from keel-block test specimens showed the following average physical properties; tensile strength, 74,600 psi; yield point, 35,900 psi; elongation, 40.9%; reduction of area, 45.5%.

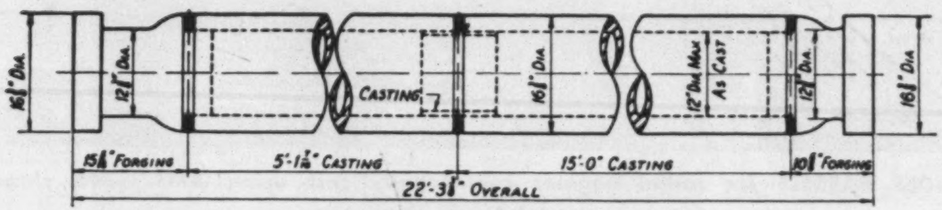
At the time no metal pattern was available which would permit casting to the desired outside diameter, including finish allowance for machining. A satisfactory and economical solution was found by utilizing an available standard metal pattern, and "lagging" up the outside by placing close fitting wood staves around the circumference of the pattern to increase its outside diameter to the proper size. Refractory sand was rammed around the staves, thus forming the tube mold.



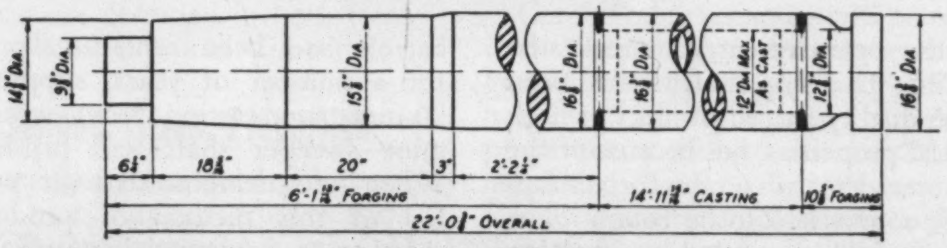
Photograph of flattening test specimen used for tests reported in above table.

Tube sections were centrifugally cast 35 in. O.D. by 32 in. I.D. by 12 ft long, then machined O.D. and I.D. and the ends prepared for welding, employing male and female joint design. The two tubes composing the body section were welded first and later assembled by welding to the statically cast end pieces to make a completed unit 28 ft long.

As the unit is a pressure vessel for high temperature service, no heat treatment was required and welds were not stress-relieved. Due to the weight, lengths and precise machining required, it was necessary to machine component parts, fabricate into subassemblies, and finally weld these assemblies together to make the completed units. The subassemblies and the completed vessels were hydrostatically tested at 300 psi and air-tested at 100 psi while submerged in water. Twelve retorts have been produced. The adoption of this method of fabrication proved to be expedient and economical.



Line Shaft – Rough Machined



Tail Shaft Rough Machined

PROPELLER SHAFT made up of centrifugally cast carbon steel tubing and 3½% nickel steel forgings.

Properties of Typical Centrifugally Cast Steel Tubes

	Chemical Composition, %							Minimum Physicals				
Type	C	Mn	P	S	Si	Other Elements	Heat Treatment	Tensile, Psi	Yield, Psi	% Elong	% R.A.	BHN Approx.
1015 Steel	0.10/ 0.20	0.30/ 0.60	0.05 Max	0.05 Max	0.15/ 0.45	0.25 Max	Norm and Temp	60,000	30,000	30	40	125
1025 Steel	0.20/ 0.30	0.60/ 0.90	0.05 Max	0.05 Max	0.15/ 0.45	0.25 Max	Norm and Temp	65,000	35,000	25	38	140
1030 Steel	0.25/ 0.35	0.60/ 0.90	0.05 Max	0.05 Max	0.15/ 0.45	0.25 Max	Norm and Temp	70,000	36,000	22	35	150
1045 Steel	0.40/ 0.50	0.60/ 0.90	0.05 Max	0.05 Max	0.15 Min	0.25 Max	Norm and Temp	80,000	45,000	16	25	160
4130 Steel	0.25/ 0.35	0.70/ 1.00	0.04 Max	0.04 Max	0.15 Min	Cr 0.80/1.10 Mo 0.15/0.25	Norm and Temp Q and Temp	90,000 100,000/ 160,000	55,000 65,000/ 145,000	18 18/ 8	35 40/ 18	185 215/ 400
4140 Steel	0.35/ 0.45	0.70/ 1.00	0.04 Max	0.04 Max	0.15 Min	Cr 0.80/1.10 Mo 0.15/0.25	Norm and Temp Q and Temp	100,000 120,000/ 180,000	65,000 85,000/ 165,000	16 16/ 5	30 35/ 15	200 250/ 450

Centrifugally cast pressure piping operating at 45,000 psi has been installed for a 16,500-ton hydraulic press. The carbon steel tubing was machined to 14.60 in. O.D. by 9.84 in. I.D. by 15 ft 4 in. long from a centrifugally cast tube of slightly larger dimensions. For heavy wall steel tubing in applications such as this, the use of centrifugally cast steel has proved most efficient and economical.

The following list of typical applications shows further some of the successful uses of centrifugally cast tubing:

- Bearing Backs—AISI 1015
- Bushings—AISI 4150
- Cams—AISI 1050
- Casing-Oil Engine Expansion Joints AISI T 321 Mod.
- Gear Hubs—AISI 4615
- Generator and Motor Frames—AISI 1005
- Hydraulic Cylinders and Rams—AISI 1025
- Jet Engine Parts—AISI 4337 Mod.
- Magnesium Reduction Retorts—28 Cr, 20% Ni
- Pump Cylinders—3 Cr, 30% Ni
- Pump Liners—Ni-Resist
- Radiant Furnace Tubes—27 Cr, 13% Ni
- Rolls, Engraving—AISI 1025
- Rolls, Furnace—15 Cr, 35% Ni

These applications point up the importance of centrifugally cast tubes as a material for engineering uses.

Acknowledgment

The author wishes to thank members of the staff of the American Cast Iron Pipe Co. for valuable help in obtaining data and illustrations used in this article.

Test of Centrifugally Cast Stainless Steel Tubing

Chemical Analysis

C	Mn	P	S	Si	Cr	Ni
0.056	0.84	0.021	0.011	1.34	24.9	23.1

Tube Dimensions

	O.D.	I.D.	Thickness
As Cast	4.87	2.94	0.96
Turned and Bored	4.64	3.38	0.63

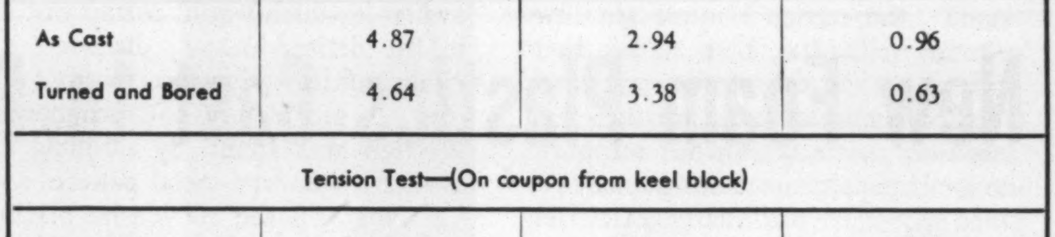
Tension Test—(On coupon from keel block)

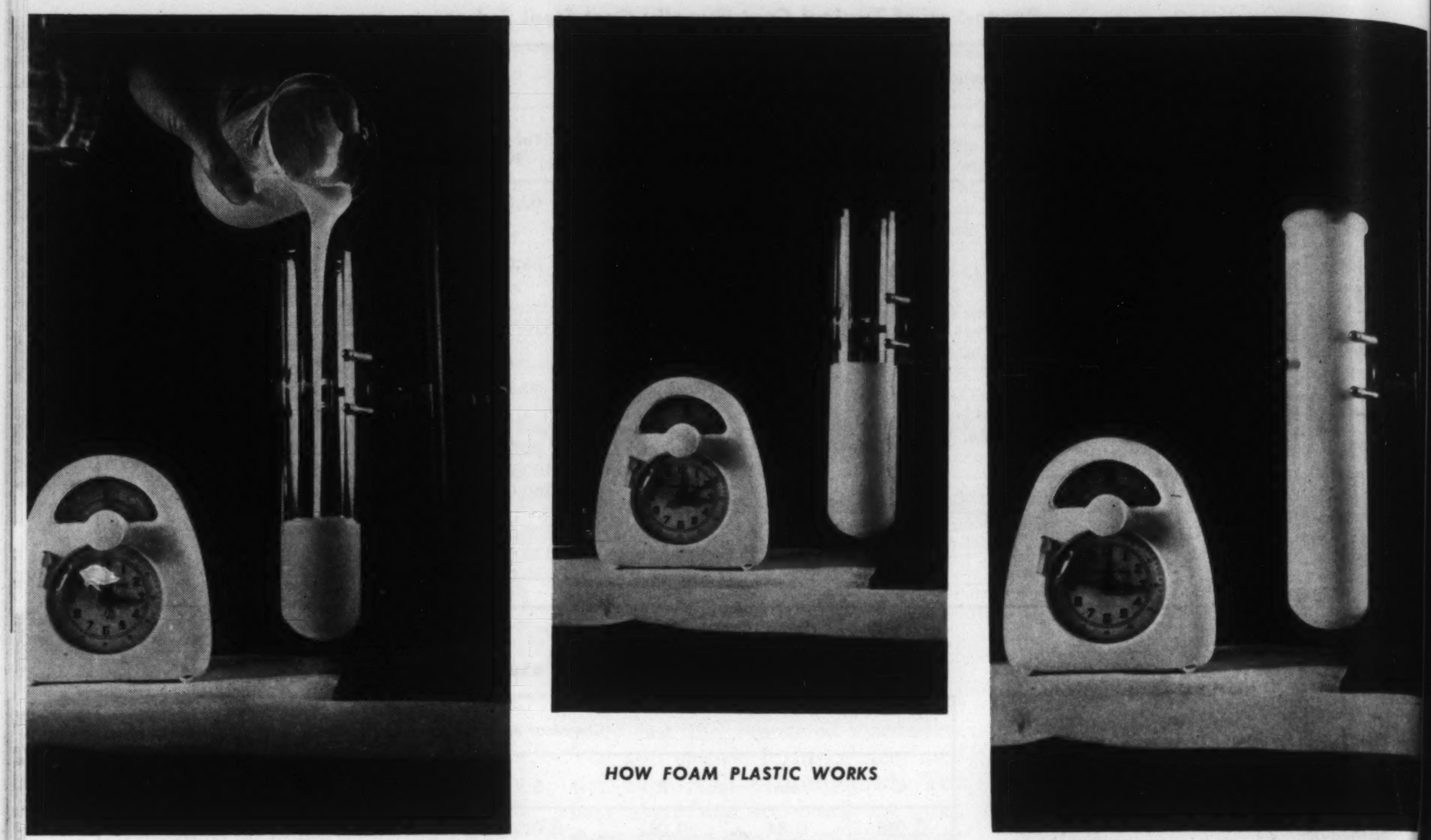
T.S.	Y.P.	Elong.	R.A.
68,100	32,300	59.0%	63.3%

Flare Tests on Turned and Bored Tube Sections

Location in Photo (See Below)	O.D.		I.D.		Expansion of I.D.[1]
	Before	After	Before	After	
Left side	4.64	5.37	3.38	4.41	30%
Top right	4.64	5.73	3.38	5.00	48%
Bottom right	4.64	5.23	3.38	4.21	25%

[1] *ASTM and AISI specs for seamless austenitic tubing require 25% expansion of I.D. for tubing of this size.*





HOW FOAM PLASTIC WORKS

1—Liquid resin catalyzed with an agent such as hydrochloric acid is poured into mold or form. 2—Within seconds the plastic begins to bubble and expand. 3—Foam plastic fills mold or form as it solidifies.

New Foam Plastics Cast to Desired Shape

Phenolic and isocyanate resins combined with chemical agents provide castable plastics. They eliminate many of the difficulties encountered with pre-foamed materials.

by JOHN STARR

● ALTHOUGH RIGID AND elastomeric plastic-foam materials have been available to industry for several years, castable foam plastics represent a relatively new development with many applicational and economic potentialities.

Castable foam plastics are available as liquid resins which can be mixed with a catalyst or hardening agent, cast in a mold or form, and foamed to any desired combination of contours and dimensions prior to solidification. This is advantageous in many circumstances because it eliminates the difficulties involved in fabricating pre-foamed stock materials.

One of the more practical castable foam plastics was recently developed by Lockheed Aircraft Corp. Known as Lockfoam, it is composed of phenolic and isocyanate resins combined with chemical agents that will cause the resins to bubble and foam as they are polymerized.

The nature of the foaming agents used by Lockheed have not yet been disclosed, but it is a fairly well-known fact that many chemicals—such as ammonium carbonate and castor oil soap—could be used to expand the base resins.

The accompanying figures indicate the action that takes place after the plastic is catalyzed with an agent such as hydrochloric acid and cast in a mold or form. First, the cast mixture occupies only a small area in the bottom of the retainer. Then it begins to bubble and expand, completely fills retainer as it solidifies.

The quantity of foam plastic required to fill a given area is variable, depending on the following factors:

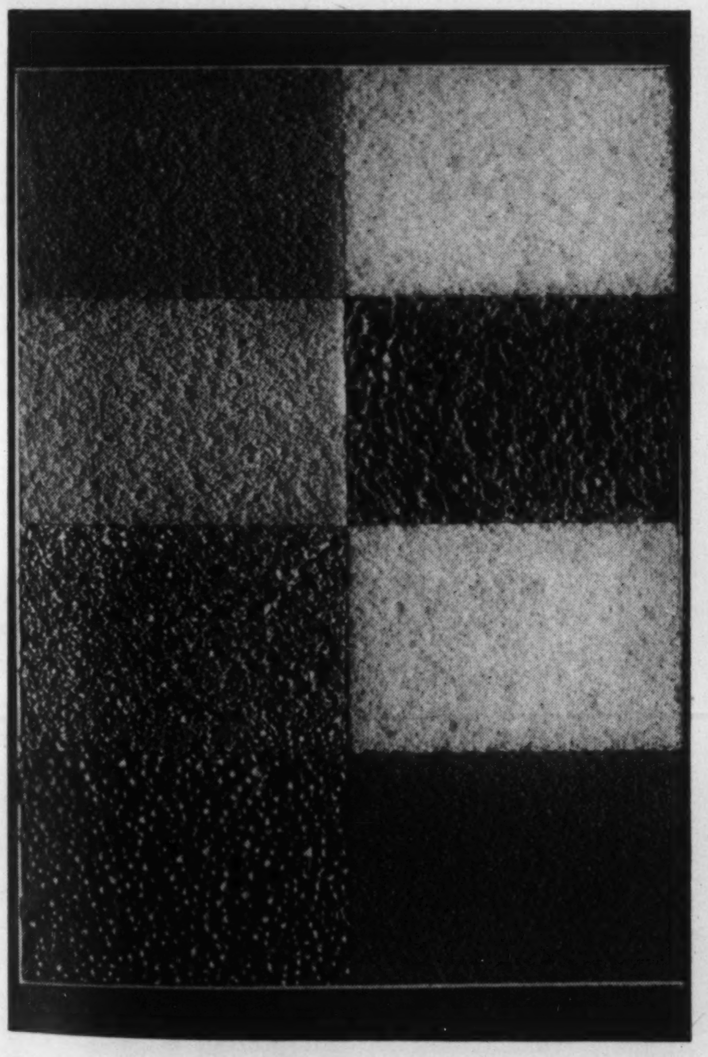
1. The amounts of resins and foaming agents used in preparing the casting mix.
2. The area in which the mix is allowed to expand, if said area is fully enclosed.
3. The physical properties desired in the solidified foam.

Minimum foaming action is preferable where a material with small bubbles or cells is essential to the maintenance of relatively high mechanical strength properties. Maximum foaming action yields a solidified material with little integral strength and extreme lightweight—about half the weight of cork.

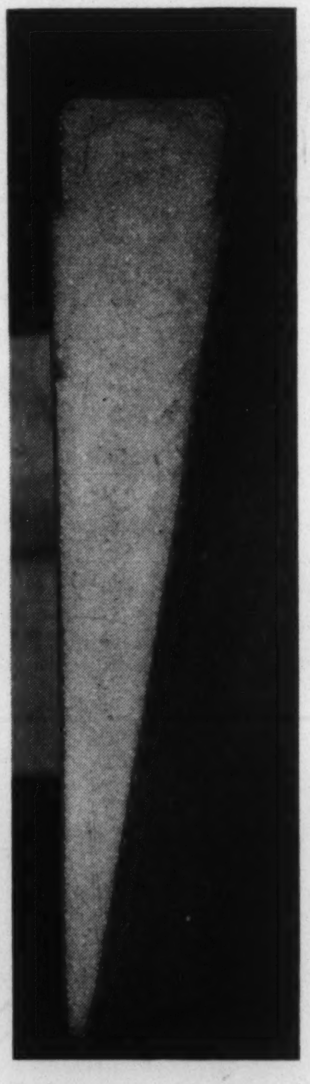
Lockheed's initial purpose in developing a castable foam plastic was to obtain an inexpensive filler of minimum weight for sheet metal aircraft structures, such as the control surfaces. In addition to saving much of the cost of fabricating or assembling internal frames or reinforcements for such sheet metal structures, Lockfoam has reduced the weight of some aircraft structures almost 30 lb per cu ft without a sacrifice of structural strength. Moreover, tests have shown that plastic foam filled parts are much superior to conventional aircraft structures in terms of vibration resistance and thermal insulation properties.

No special tooling is essential to the successful use of Lockfoam as a filler, since the structure to be filled can be used as a pouring form for the resinous mix. However, the structure may be externally reinforced if it lacks the slight rigidity required to prevent distortions due to slight foaming pressures.

Heat up to about 200 F can be used to accelerate the solidification of Lockfoam, but this is rarely necessary because the basic resins can be catalyzed for polymerization at room temperature in a matter of minutes without difficulties of the type that could be expected in using conventional casting resins (which are not supposed to bubble or foam as they solidify).



Cross sections of solidified castable foam plastics show differences in air-bubble cells that can be obtained.



End view of a sheet-metal airfoil, in which Lockfoam was used as a reinforcing filler material.

During the solidification process, the foamed-plastic's natural tendency is to adhere strongly to adjacent surfaces of wood, paper, fabrics or metals. This is desirable where the resinous mix is cast in the structure that requires a foamed-plastic filler. But, if necessary, adhesion can be prevented by coating the inner surfaces of a mold or pouring form with a wax-type parting agent.

As originally developed, solidified Lockfoam was a rigid material with just enough "give" to prevent ruptures due to sudden loads of the types that can be resisted by aluminum sheet facing materials. However, experience has proved that the basic resin composition can be plasticized and modified with elastomeric compounds for almost any specified degree of flexibility.

Therefore, applications for the new castable foam plastic (which is now being made for Lockheed by American Latex and Nopco Chemical companies) are increasing almost daily. Such applications at present include the fabrication of lifebelts, soundproof earmuffs, insulated packages, liners for crash helmets, and fireproof doors.

In connection with the latter application, it should be noted that Lockfoam alone—like all thermosetting plastics—will char in the presence of an open flame. However, it will not support combustion. Therefore, when used as a filler between two layers of metal in a door or similar structure, the solidified foam is fireproof for most practical purposes.

Foamed and foamable plastics similar to Lockfoam are currently being manufactured by E. I. du Pont de Nemours & Co., Inc., U. S. Rubber Co., Sponge Rubber Products Co., Dow Chemical Co., General Electric Co., and Bakelite Co. Of these, Bakelite's foamable phenolic most closely resembles Lockfoam and has the definite advantage of a lower price; but, as yet, it is adaptable only to packaging applications.

The remaining products are related to Lockfoam in terms of finished physical properties (that is, aside from the fact that some are thermoplastics with less heat resistance); and most of them are available as prefabricated stock materials at a relatively low cost. But, as yet, few can be foamed-in-place like Lockfoam by the manufacturer who lacks specialized mass-production equipment for the processing of foamable plastics.

Materials at Work

Here is materials engineering in action . . .

New materials in their intended uses . . .

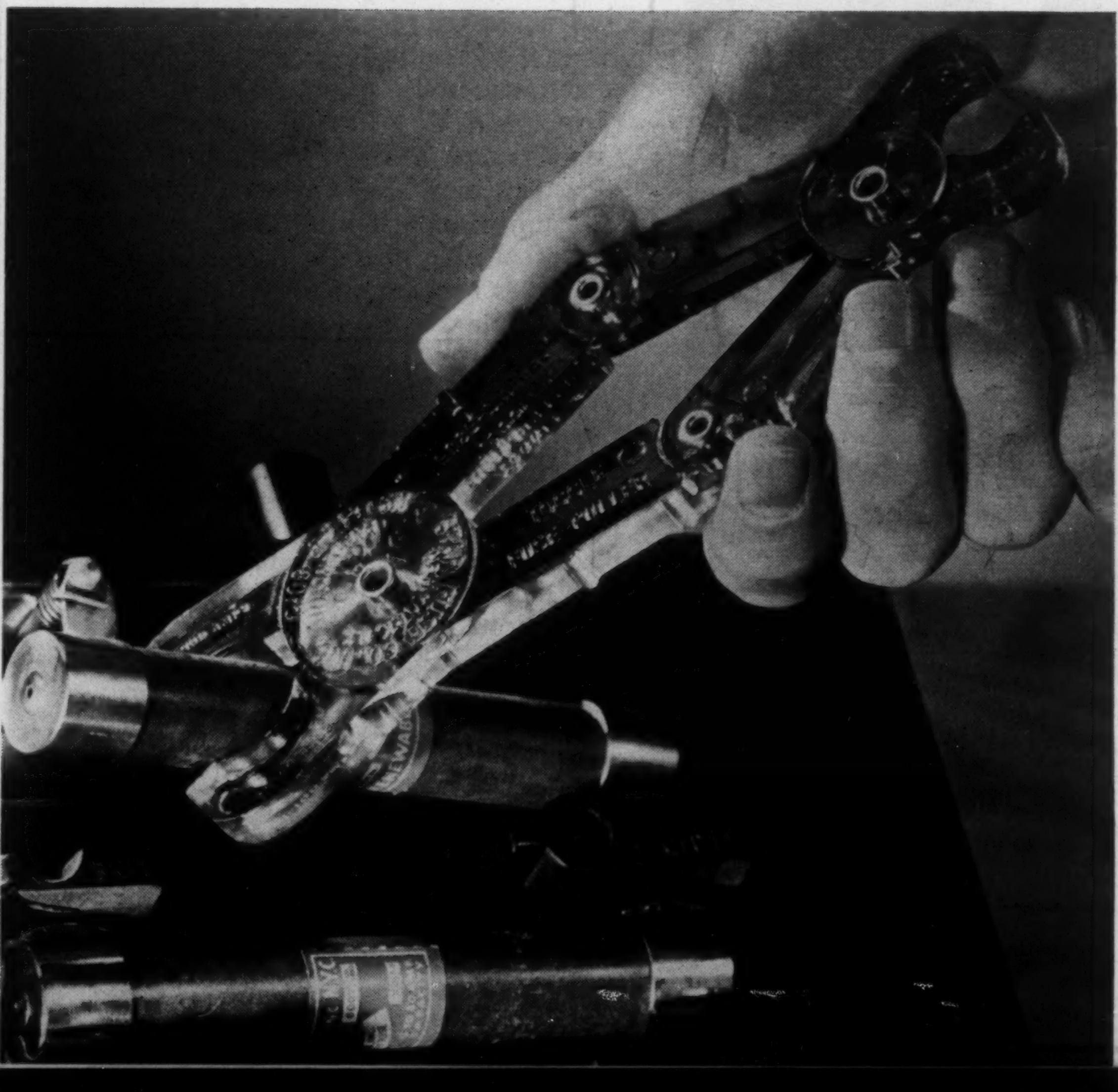
Older, basic materials in new applications . . .

FLAME-HARDENED TRUCK CENTER CASTINGS

Wearing life of locomotive tender truck center castings has been substantially increased on the Illinois Central Railroad by the oxyacetylene flame-hardening process. This method has practically eliminated abrasion and burring which generally cause center castings to lock together.

An Oxweld W-24-R blowpipe equipped with a multi-flame head is used. Castings are machined lightly to a specified diameter in preparation. Male castings are laid flat on a machine-rotated mandrel for face hardening, and on the side for sidewall treatment. Inner walls of female castings are treated in the same manner. The castings are rotated at approximately 3½ in. per min under the flame and simultaneously water-quenched.

Truck center castings consist of cast steel of approximately 0.25% carbon content. They average 129 Brinell before hardening, and 300 Brinell after being treated. Depth of the flame-hardened area ranges from ⅛ to ¼ in. Illinois Central Railroad estimates flame-hardening increases center casting life three to four times.



BUTYRATE FUSE PULLER

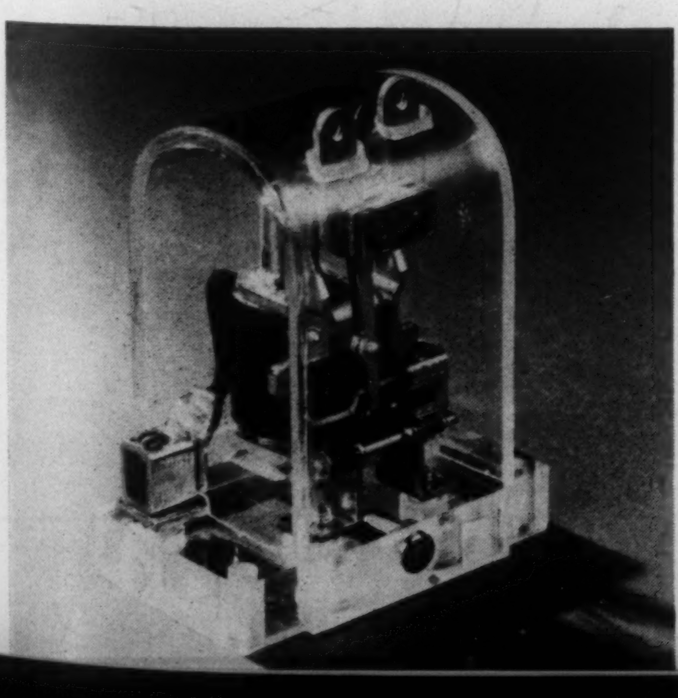
The Toggle Fuse Puller is molded of Tenite cellulose acetate butyrate. The tool is assembled from four molded parts. These are hinged together in a toggle design which gives nonslip grip for removing or replacing fuses. One end of the tool handles fuses up to 30 amp—the other, fuses from 31 to 100 amp. Tests indicate that this fuse puller has double the strength of old-style fibre fuse pullers, and is capable of withstanding over 4000 volts breakdown after 24-hr immersion in salt water. It weighs only 2 oz. Tenite is supplied by Tennessee Eastman Co. Parts are molded by Popular Plastic Products Corp. for Star Fuse Co., Inc.

RUBBER RAILROAD CAR CONDUIT SEAL

A new conduit seal manufactured by the Vapor Heating Corp. is being used in railroad passenger car heating systems carrying 400 F steam under 250 psi. Hycar American rubber, a product of B. F. Goodrich Chemical Co., is used, since the sealing action and flexibility could not be affected by hot steam. Hycar resists abrasion, weather, as well as oils and chemicals.

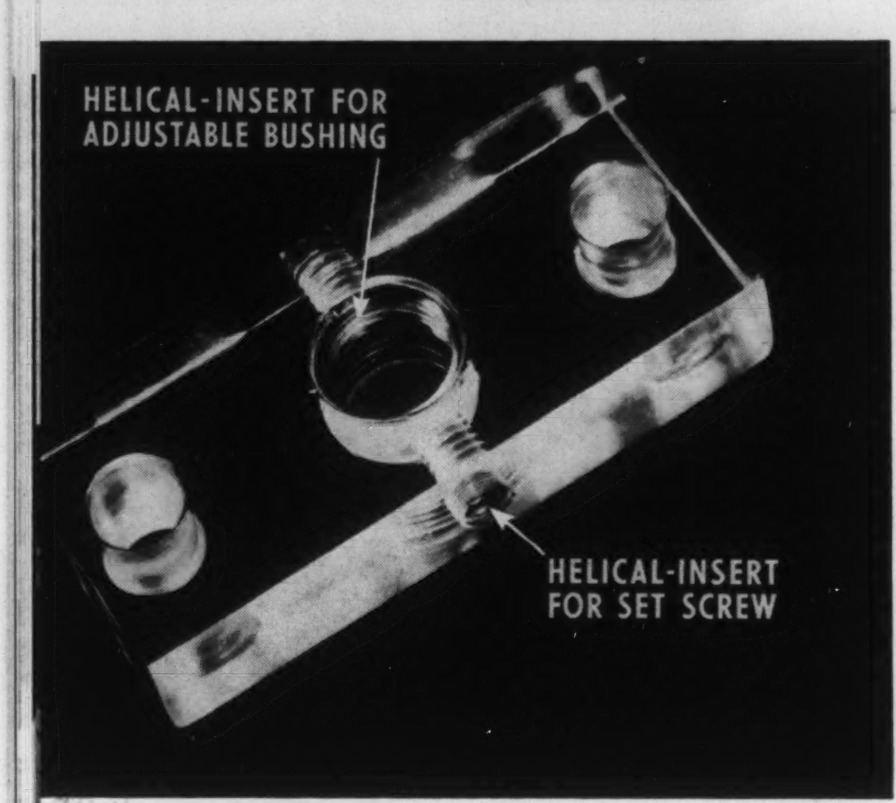
Each metallic conduit between the cars has eight swivel joints to absorb the constant jolting action of the moving car. At every joint is an asbestos-faced seal—2¾ in. O.D., ⅛-in. wall, with a 1-in. skirt.

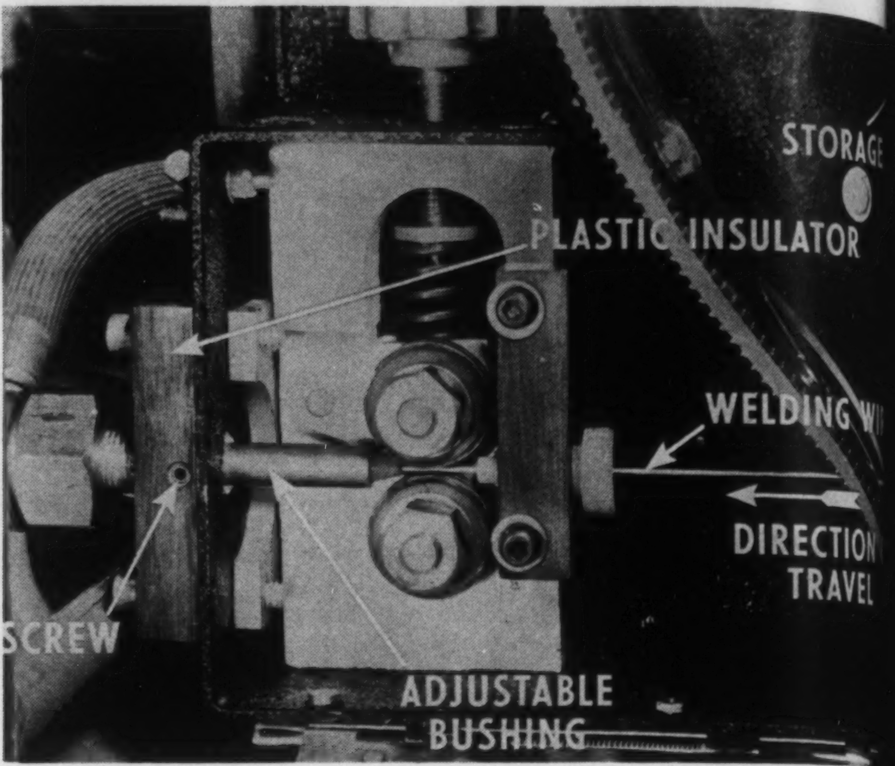
The heating steam is hottest in the cars near the engine. By the time the steam reaches the end cars, it might be cooled down to only boiling water. A conduit seal is needed that will not readily deteriorate in fluctuating temperatures. The seal must also resist sub-zero weather should the passenger car be sitting idle in a railroad yard. Hycar rubber remains resilient and flexible in such extreme temperatures.



SEALED SILICONE RELAY TIME ELEMENT

The Type C Silico-O-Netic overload relay combining extremely high-speed operation under dangerous conditions with time delay for starting inrush has been introduced by the Heinemann Electric Co. The relay has a hermetically sealed brass tube extending through and beyond the solenoid coil. The tube holds a movable iron core and is filled with a silicone liquid. On starting inrush or small overloads, the magnetic force is not sufficient to attract the armature. It does, however, draw the core into the field at a rate controlled by the viscosity of the silicone fluid.


HELICAL-INSERT FOR ADJUSTABLE BUSHING
HELICAL-INSERT FOR SET SCREW



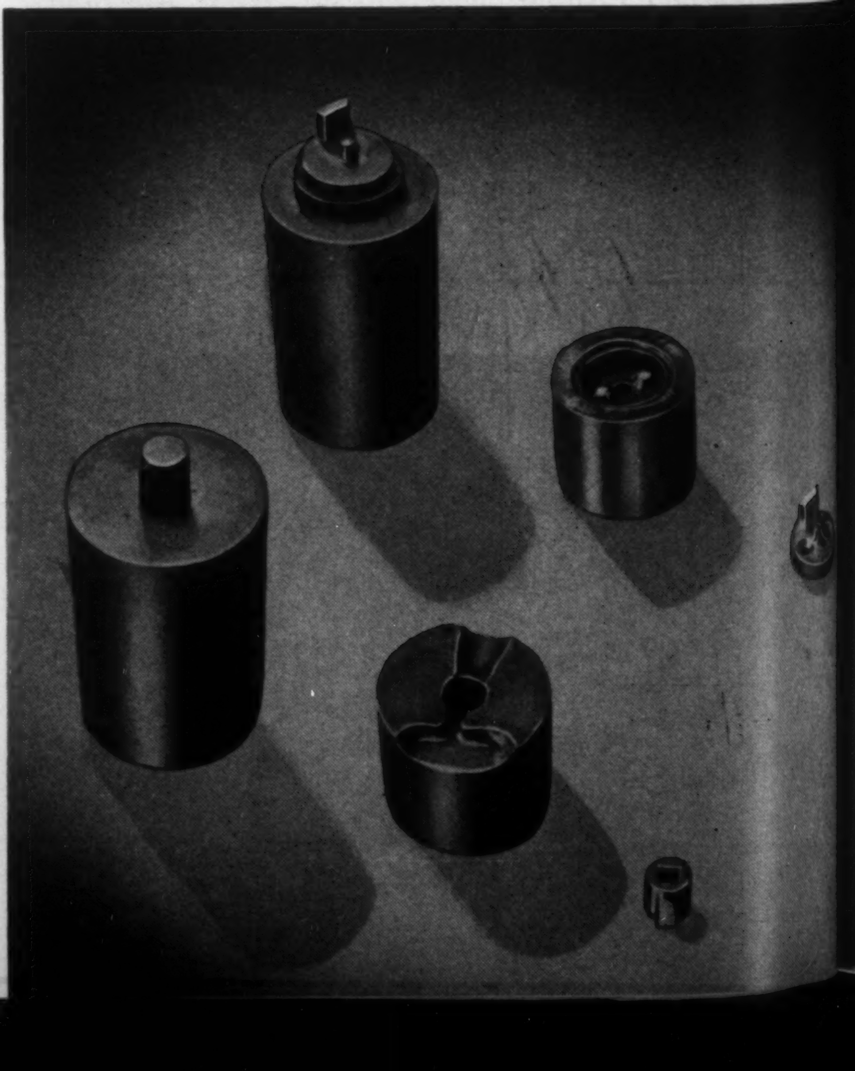
STAINLESS STEEL THREAD INSERTS IN LAMINATED PHENOLIC Stainless steel wire thread inserts in a laminated phenolic insulator block of an automatic arc welder solve three problems for the Air Reduction Co. This block must: (1) prevent welding current in the continuous wire from grounding out through the frame; (2) support the adjustable threaded bushing through which the wire passes; and (3) provide adjustment to different sizes of welding wire.

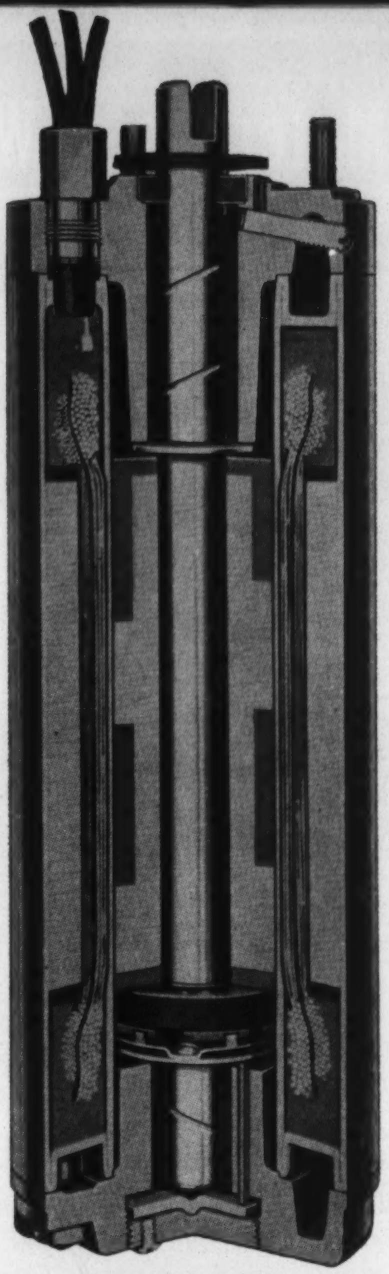
Each block contains three thread inserts. Two, in the set-screw holes, strengthen the plastic threads against stripping and protect them from wear. The third, in the larger hole, provides the same protection and also acts as a brake band around the threads of the bushing. A change from one size wire to another required loosening of the set screws, insertion of a different nylon sleeve in the bushing, and readjustment of the bushing so the tip of the nylon supporting member is close to the feed rolls (to prevent wire buckling). The adjustment is maintained by tightening the set screws.

Because thread inserts provide higher thread flank engagements, insert-protected holes will safely withstand higher loads. Adjustments will not cause any appreciable wear of the liners. The insert prevents the set screws from marring the thread on the adjusting bushing. Because the insert is flexible, it clamps the bushing when set screws are tightened and releases it when they are loosened. The thread inserts are supplied by Heli-Coil Corp.

BERYLLIUM-COPPER DIE CAVITIES These two zinc die cast lock components are quite intricate. The projecting lugs are actually cam surfaces. Any other production method besides die casting would be extremely expensive.

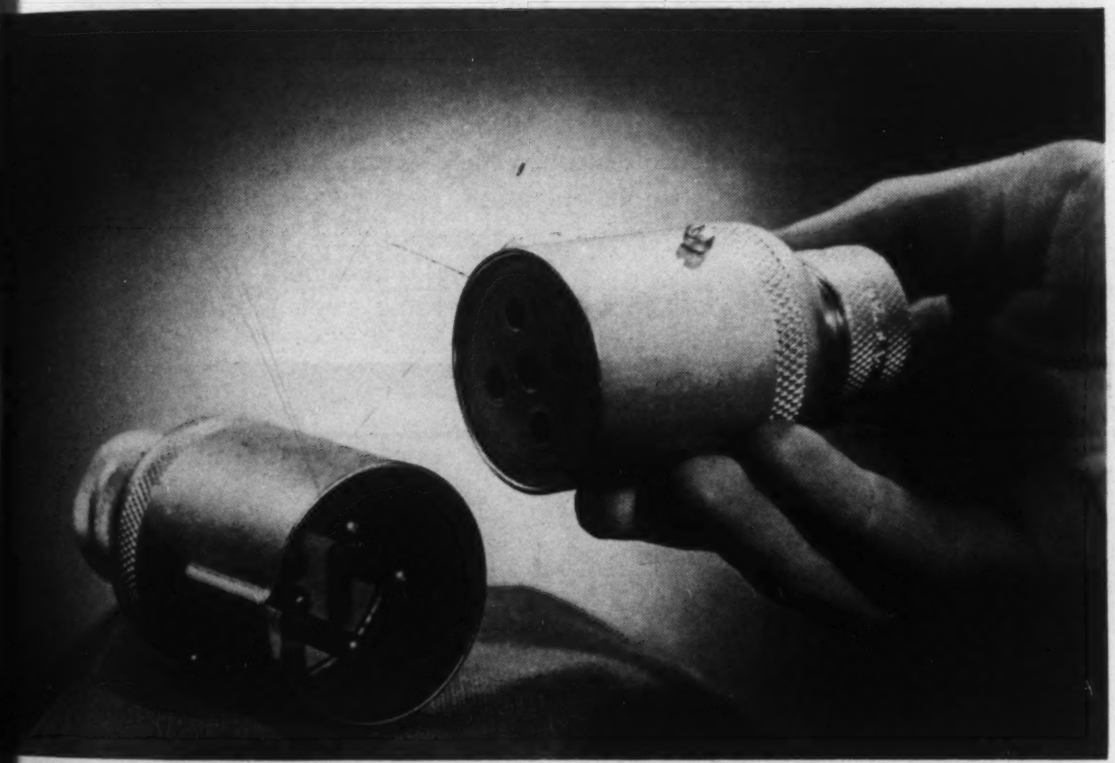
The big problem in die casting was to make the die cavities. Hobbed, rather than machined, dies were used. In hobbing, a hard steel male pattern is pressed into softer steel to form a female cavity. This is done when it is more feasible to machine a male duplicate of a part than to cut a female impression. With these two parts, regular hobbing was not possible since nonsymmetrical hobs might break or distort under the pressures required. Instead, molten beryllium-copper was poured around the hobs and pressure was applied to form the cavities. Much less pressure was necessary than for regular hobbing, and there was no difficulty with broken lugs. The picture shows, left to right, the hob, the beryllium-copper die cavity, and the finished casting in each instance. The parts were cast in zinc furnished by New Jersey Zinc Co.





CARBON GRAPHITE PUMP BEARINGS

A deep well pump in which the electric motor and the pump are located at the bottom of the well is produced by Franklin Electric Co. By sealing all the electrical components in a watertight casing and attaching the drive directly to the pump impeller, all the working parts of the pump and drive are built into the unit attached to the bottom of the pipe. Lubrication is arranged for by using a carbon-graphite plate for the thrust bearing and two carbon-graphite radial bearings for other friction surfaces. The carbon-graphite bearings, made by United States Graphite Co., are water-lubricated, but will not gall even if the surfaces run dry for a few moments.



ALKYD PLUG INSULATION

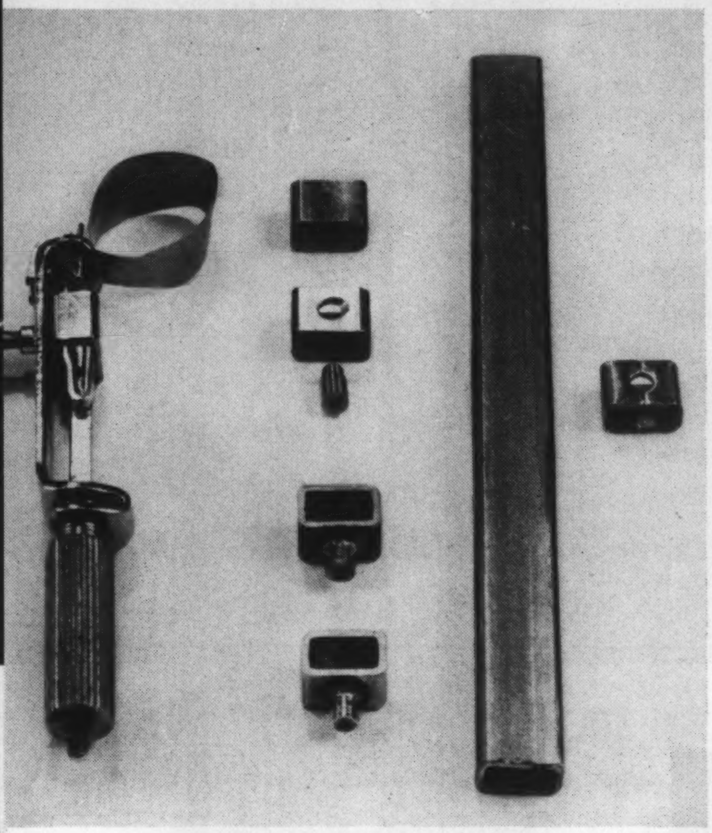
For unusual applications, particularly where high temperatures are encountered, the Pyle-National Co. has chosen Plaskon alkyd as the insulating material in their Triploc plugs and receptacles. These are used on portable electrical gear, such as high-cycle tools and lighting and power equipment. They are also used on remote control, instrumentation, communication, sound and inter-vehicular circuit equipment.

Alkyd was selected because of its electrical qualities. It provides the necessary dielectric strength, arc resistance and dimensional stability. It is not affected by heavy vibration or temperature variations and does not crack on aging.

Pyle-National also uses Plaskon alkyd as the insulating material in their Quelarc line of circuit breaking plugs and receptacles where unusually high electrical and physical demands are encountered.

PHENOLIC SLIP RING ASSEMBLY

Auburn Button Works, Inc. is molding this slip ring assembly for the Raytheon Manufacturing Co. It is used for radar equipment on small craft to transmit electrical impulses from the stationary section of the ship to the revolving part of the scanning mechanism. The assembly, which is transfer molded of Bakelite phenolic molding compound, measures 5¼ in. high. The outside dia is 7 in., and the inside 5¼ in. The rings, which are made of coin silver, are integrally molded in one operation with leads from each ring terminating in threaded inserts at the top of the assembly. Top and bottom drive rings are inserted after the molding operation.

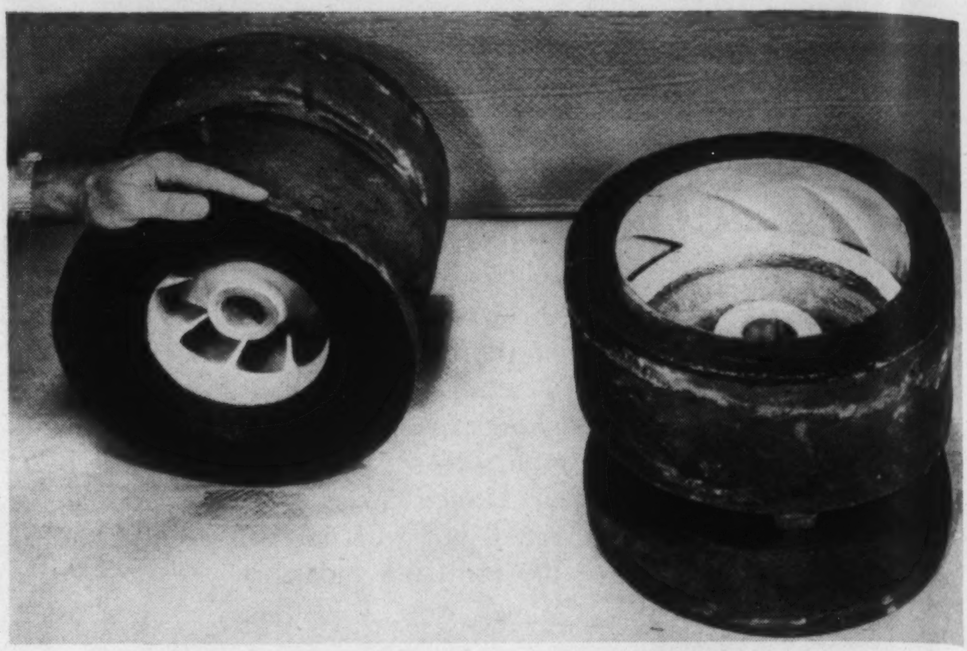


SEAMLESS STAINLESS STEEL TUBING DENTAL PART

A dental matrix is that narrow band of soft metal which is clamped around a tooth to form a sort of coffer dam for filling tooth-edge cavities. The matrix is held firm around the tooth in a hand-screw-adjusting matrix vise. Working in conjunction with designers at J. W. Ivory & Co., Superior Tube Co. metallurgists eliminated six steps in the manufacturing of thumb screw vises.

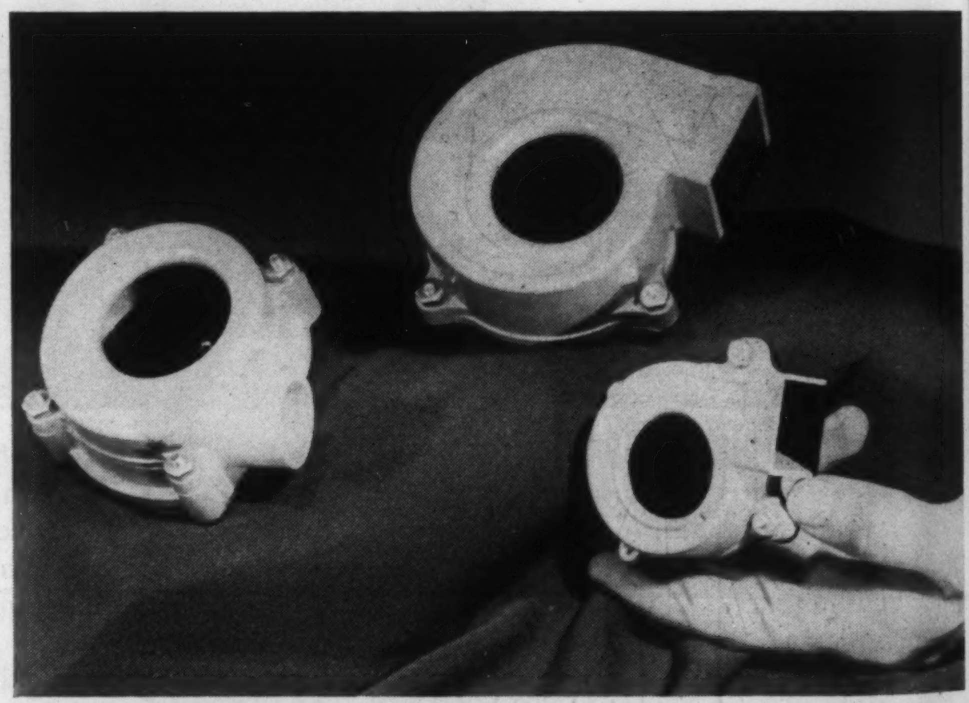
The operations formerly used in manufacturing the vises from sheet steel were bending, seam soldering, blanking, burring, heat treating and hand polishing. It was felt that greater strength would be obtained if the soldered seam could be eliminated. Surface smoothness on the inside and outside diameters was also important since the matrix must be easily sterilized.

The solution consisted of delivering to the manufacturer a pre-shaped seamless tube to his I.D., O.D. and wall-thickness specifications. This pre-shaped tubing is cut to size, drilled for thumbscrew mounting, and assembled into the finished matrix. A smooth and sanitary surface is retained in the bright annealed condition. Greater strength and a surer grip for the thumbscrew mounting are assured by doing away with the soldered seam and locating the threaded tightening hole in an unbroken seamless tube surface. The finished product and the process steps are shown, together with the old-style, formed vise (right).



PORCELAIN ENAMELED PUMP HOUSING INTERIOR

Indicative of the new uses of porcelain enamel for heavy duty industrial applications is the interior coating on this deep well pump housing produced by Barrows Porcelain Enamel Co. The housing is part of a pump used to draw water from extreme depths. The enamel coating covers the area where the water is forced upward. This is the greatest area of friction, and the coating was specified to give fast flow. At the same time it protects the cast iron metal housing against rust and deterioration. Each housing of the multi-stage pump has the coating. It is applied evenly, in a single operation, over the circular walls as well as the tapered fins.



GLASS-REINFORCED ALKYD BLOWER HOUSINGS

Bridges Plastic Products molds these housings for motor blowers for Electroflow Pumps, Inc. out of Plaskon glass-reinforced alkyd. The material must withstand the pressure built up in cooling systems which disperse heat from aircraft generator systems. Extreme temperature changes, from —69 to +249 F, must be withstood. Light weight is also a requirement, of course. The mixed glass-alkyd molding compound gave the necessary thermal and mechanical shock resistance. Electroflow estimates that it saves 22% on breakage experienced with previously used materials.

How Cold Treatments Improve Performance of Materials

by **JOHN L. EVERHART**, Associate Editor, Materials & Methods

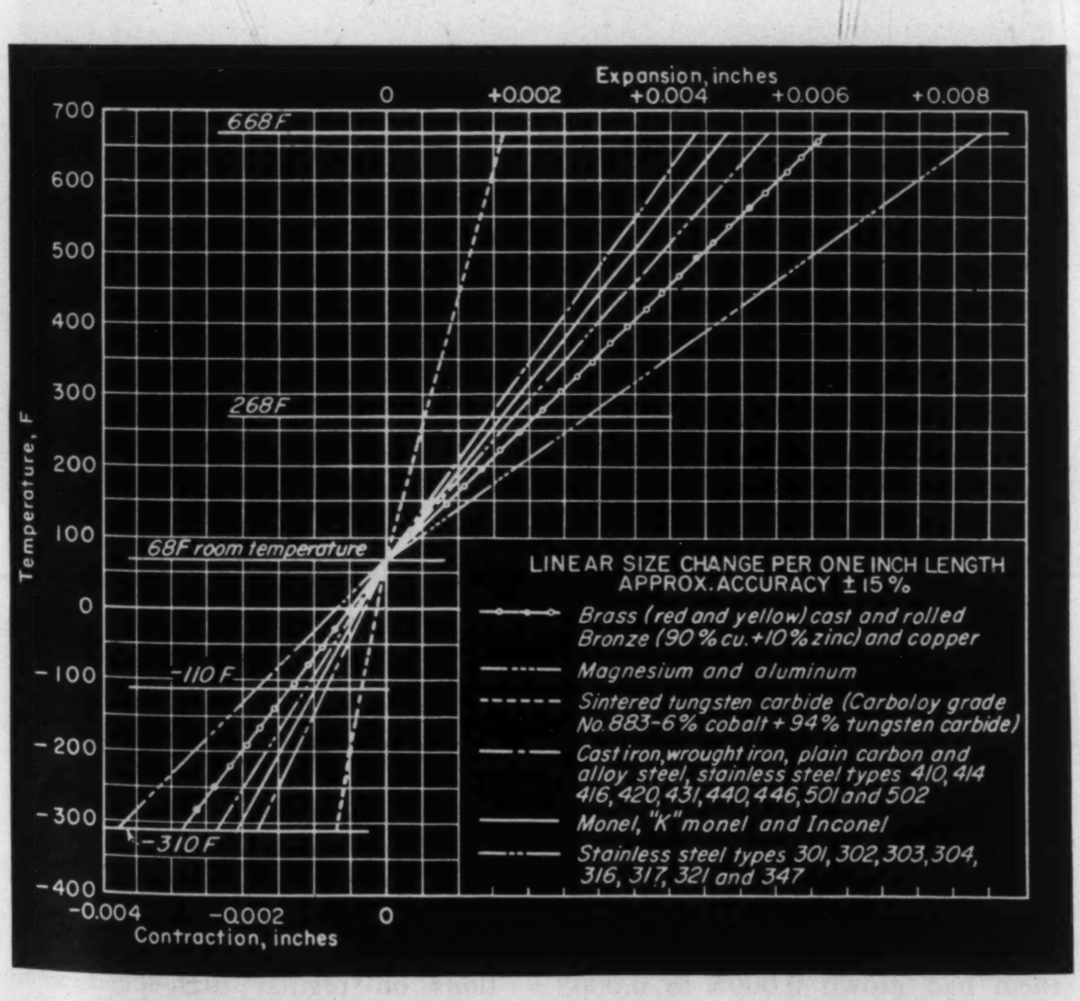
Refrigeration is being used to advantage to stabilize metals, increase tool life and improve machinability.

● THE FIRST REACTION of an engineer, considering the application of temperature to an industrial operation, is to raise it. Not so well known are the beneficial effects often achieved by reducing the temperature. Although cold treatments have been used for years in shrink fitting and certain other processes, the production of commercial refrigerating units capable of holding temperatures below –100 F has increased interest in the application of low temperatures generally.

The principal applications of refrigeration in the materials field at present are (1) stabilization of steels, (2) shrink fitting, (3) prevention of the aging of aluminum alloys, and (4) cold machining and grinding. Other applications still in the development stage point to increasing use of low temperatures in the future.

Stabilization of Steel

Hardening of steel involves heating the material to a temperature high enough to form austenite, quenching to transform the austenite into martensite, and tempering to obtain the desired final structure. Under the usual conditions, the transformation from austenite to martensite is not complete. The percentage of austenite retained depends on a number of factors, including composition, quenching temperature and grain size. Upon storage at ordinary temperatures, some of the retained austenite will transform slowly, with resulting increase in hardness and expansion of the part.



The approximate changes in size which occur when parts are heated or cooled can be determined from these curves. (From E. J. Weller and A. K. Frank, Tool Engineers' Handbook)

Although the reason was unknown, this tendency for dimensional increase has been recognized for many years, and manufacturers of gages and other parts used at high hardness levels often stored the parts for several years to stabilize them before performing the final finishing operations.

Investigation of the transformation of austenite led to a study of subzero cooling and it was found that such treatment resulted in transformation of part of the retained austenite with an accompanying increase in volume, in magnetic induction and in hardness. Although complete transformation of austenite into martensite was not achieved even by cooling to –300 F, sufficient conversion occurred within the range –100 to –150 F to stabilize the steel for most applications. It was indicated also that sub-zero treatments were more effective if applied immediately after quenching the steel.

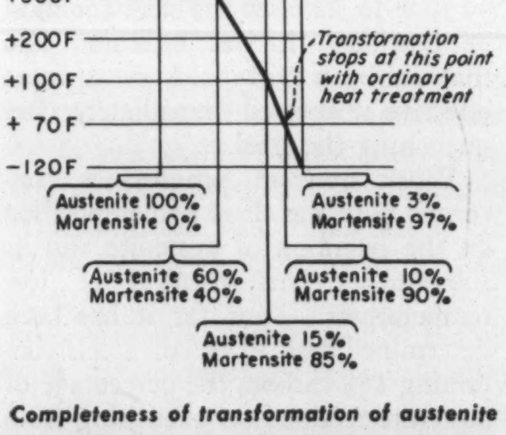
Work now in progress is concerned with the effect of composition on the retention of austenite and its subsequent transformation at low temperatures. Thus far it has been determined that, in certain steels containing 1% carbon, the percentage of austenite retained on quenching from 1650 F increases rapidly with increasing manganese content up to 6%, above which there is no transformation of the austenite. Refrigeration results in transformation of part of the austenite, the proportion decreasing with increasing manganese up to 9%, above which no transformation occurs as a result of refrigeration. These data were the first published in a series of investigations designed to determine the effect of composition on the low-temperature transformation of austenite.

Among the first practical applications of the discovery that retained austenite could be transformed into martensite at sub-zero temperatures was the production of gages and high-precision machine parts. Instead of storage for a period of years, the parts were refrigerated and suitable cycles of operations were devised to assure transformation of sufficient austenite to achieve dimensional stability. Various methods were developed but the following are typical.

Gages can be stabilized by a series of treatments in which they are cooled to –120 to –150 F, allowed to return to room temperature, then tempered at a temperature low enough to retain a hardness of about R_c65. The cycle is repeated as often as necessary to obtain stable dimensions. For most applications, 1 or 2 cycles are sufficient, but as many as 5 or 6 are used for master gages requiring extreme accuracy.

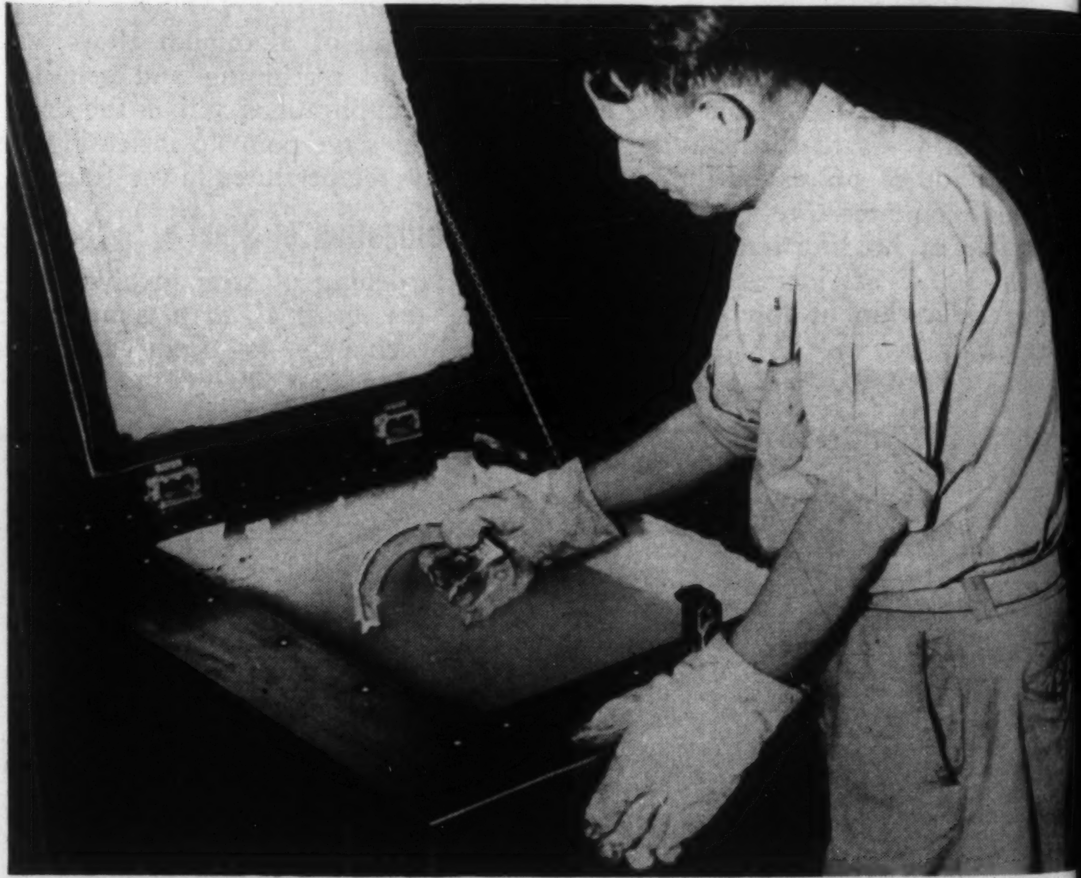
A similar procedure has been used to stabilize large machine parts. These parts were cooled to –75 F, allowed to heat to room temperature and tempered at 300 F, the cycle being repeated twice. No significant distortion was found after the parts had been in storage for two years.

The sluggishness of the austenite transformation at room temperatures is shown by the following incident. Plug gages, after being in service for over 30 years, had worn below tolerance limits. Several of the gages, ranging from 1 5/16 to 1 15/16 in. in dia were cooled to –160 F and held for periods ranging from 5 to 15 hr. After this treatment some of them had grown 0.0005 to 0.0008 in. per in. of dia, which proved to be sufficient to permit refinishing to the correct size.



Completeness of transformation of austenite to martensite in high-speed steel upon quenching and tempering. (R. S. Jamison, Modern Machine Shop, Oct. 1951)

CUTTING QUALITIES of drills and milling cutters are often improved by refrigeration. Gage blocks are stabilized by similar treatments. (Bowser Technical Refrigeration Div.)



SHRINKING a component for the braking system of the Indian motorcycle by cold treatment. After shrinking, the part can be dropped into place with its mating part. (Bowser Technical Refrigeration Div.)

Retained austenite can be a problem also in heat treated steels. Tool steels are often used after a low temperature tempering treatment and transformation of austenite may be far from complete. Refrigeration can often be employed to assist in the transformation. Extensive investigations on regular high-speed steels have shown that transformation can be assisted by cooling to the range

STABILIZING *16-ft flame-hardened lathe bedway wear strips by refrigerating for 24 hr at —120 F. (Sub-Zero Products Co.)*

MACHINING *of various highly alloyed metals has been improved by cooling the work with carbon dioxide. (Air Reduction Co.)*

–100 to about –150 F, while temperatures above —100 F are not so effective. The refrigeration treatment can be incorporated immediately after quenching for hardening or can follow tempering, but in all cases a final tempering operation is necessary.

Cold treatments are not always effective in improving the properties of these steels, and it has been suggested that refrigeration should be considered if the part is file hard after heat treatment but has a Rockwell hardness lower than C55.

Considerable improvement in tool life has been reported during the past few years as the result of incorporating a cold treatment into the heat treating cycle. For example, cold forging dies of 1 carbon-5 chromium-1% molybdenum steel for the production of screw drivers were hardenable only to Rockwell C60 by ordinary procedures without danger of cracking. After refrigerating these dies at –150 F for 10 hr and retempering them at 200 F, hardness increased to R_c65 and the life was doubled.

Recently, satisfactory results have been obtained by heat treating tools in the regular manner, finish-grinding them and refrigerating them at –120 F for periods up to 6 hr. Some interesting results have been reported with tools handled in this manner. Tool life was increased five times by applying this treatment to standard twist drills made from 4340 steel; milling cutters were usable for 24 hr in contrast with 7 hr for the untreated cutters; molybdenum high-speed steel hack saw blades lasted twice as long after treatment; and high-speed steel burnishing tools have shown an average increase of three times the life.

Cold treatments are not always effective in increasing tool life, particularly when tools have been hardened, tempered and stored. Drills from two different batches were refrigerated at –120 F after a period of storage and retempered at 400 F. Drills from the same batches had produced an average of four pieces per grind before refrigeration. After the cold treatment, the drills from one lot produced 30 to 45 pieces per grind while those from the other lot were no better than the unrefrigerated drills.

Results such as these are probably responsible for the disagreement which exists over the value of cold treatments. While some authorities are convinced that such treatments are effective in increasing tool life, others contend that properly hardened and completely tempered tools are not improved by refrigeration. Until more information is available on the influence of such factors as composition, the engineer must determine by actual tests whether cold treatments are useful for specific applications.

Cold treatments have been employed with carburized steels also. After conventional quenching and tempering, particularly of the alloy grades, the core may have the required hardness while the case is softer than desired. Holding these steels at temperatures below –100 F for several hours may promote transformation of the retained austenite accompanied by an increase in hardness of the case. Refrigeration followed by tempering has been reported to increase the wear resistance and hardness of carburized gears, valve components and other carburized parts.

The investigation of low temperature treatments is not confined entirely to high carbon steels. Experimental work has indicated that the deep drawing qualities of low carbon steels can be improved by refrigeration at –150 F before forming at room temperature.

Shrink Fits

Three methods are usually used to obtain close-fitting parts: (1) pressure, (2) expansion of the external member, and (3) contraction of the internal member. Contraction by refrigeration has become an important method of obtaining such fits. It has the advantage over pressure fitting of reducing the possibility of damage to the part, and it eliminates the danger of softening heat treated steel parts, which is always possible if heating is used to expand the female member of the assembly.

Cold treating is employed in inserting automobile valve seat rings in cylinder blocks. Chromium-molybdenum cast iron has been used for the seat rings in engines having cast iron heads and bronze in those having aluminum heads. By use of suitable fixtures for handling and seating chilled rings, production rates of four rings per min have been reported.

The assembly of case hardened ring gears by heating the external member involves the danger of softening the part, particularly when small gears are being assembled, because rather high temperatures must be used to obtained the necessary expansion. If the internal member is given a sub-zero treatment, assembly can be made with the other part at room temperature or heated to a temperature low enough to avoid the danger of softening.

Among many other applications are fitting of sleeves on hydraulic press cylinders, assembly of an aluminum head and a steel cylinder for an aircraft engine using a combination method involving heating the head and cooling the cylinder, fitting steel ball bearing rings into aluminum wheels, and insertion of ball bearings into bearing races by hand instead of by pressure fitting as used previously. Shrink fits have also been used in replacing worn axle spindles on locomotive crank shafts and for the replacement of other machine parts.

Prevention of Aging

Certain aluminum alloys are softened by quenching from a suitable temperature and develop their maximum strength by precipitation hardening after this treatment. This precipitation hardening or aging occurs at room temperature. Such alloys can be formed readily in the quenched condition but become progressively more difficult to work as aging proceeds. However, aging can be retarded by storage at low temperatures.

Rivets of 17S quenched in cold water often become too hard to drive in 2 hr if allowed to age at room temperature. If aging is retarded by storage at 32 F, the rivets remain soft enough to drive after 6 hr, while storage at –50 F keeps them soft enough to be driven after 2 weeks. Rivets of 24S act similarly.

The cold treatment of rivets has been practiced for many years, but this procedure is being applied increasingly in the aircraft industry for other parts. The material is quenched, blanked to the desired form, and stored at temperatures which range from 32 F to –40 F, depending on the practice prevailing in a particular plant. Forming is subsequently performed on the soft material and the part is allowed to age naturally at room temperature. This procedure is particularly valuable for large slender parts which have a tendency to distort, if they are heat treated after forming. An aircraft organization reported that such a cold treatment practically eliminated cracking of parts during forming and increased production rates.

The procedure has been applied also to aluminum alloy hydraulic valve castings. Before cold treatments were employed many parts were spoiled by tearing during drilling and tapping, and were frequently distorted severely. After refrigeration at —150 F, the valves could be drilled and tapped without tearing and close dimensional tolerances could be held.

Cold Machining and Grinding

Although the use of liquid carbon dioxide as a tool coolant is not new, this procedure has received considerable attention recently for improving the machining of various alloys. In this process, liquid carbon dioxide is released at the contact point between tool and work. Upon release, part of the carbon dioxide solidifies as snow, the remainder gasifies. On solidifying, the carbon dioxide absorbs heat from the surfaces with which it is in contact, thus cooling these areas. The snow then evaporates gradually. By suitable adjustment of the flow of liquid carbon dioxide to keep work and tool edge at room temperature, machining operations can be performed at relatively high speeds on many materials which are difficult to machine. Since the carbon dioxide evaporates, there is no residue to contaminate the chips, a distinct advantage when expensive materials are handled.

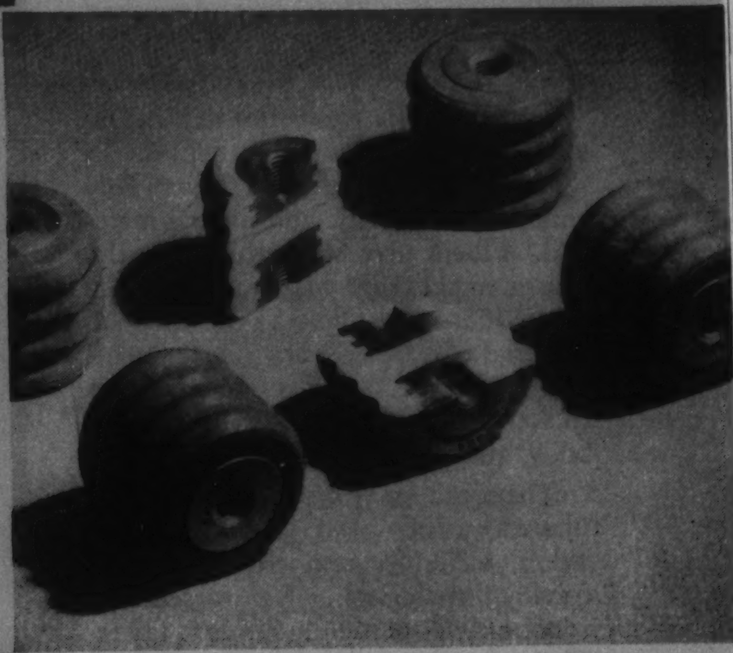
This machining procedure has been applied to hardened steels, stainless steels, high nickel alloys, turbine alloys and titanium. Operations have included turning, milling, drilling, tapping and broaching. All machining is done dry using carbon dioxide to cool the work.

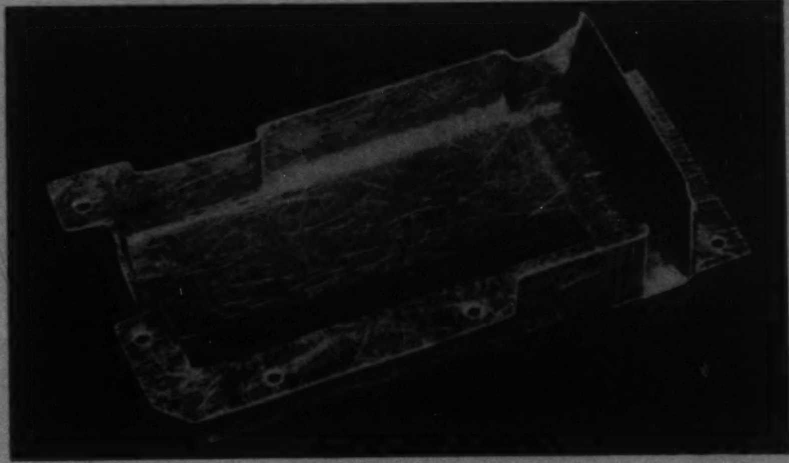
Typical of the improved performance reported are: a chromium molybdenum steel gear blank hardened to Rockwell C43, which required 4 hr to machine, required only 1 hr when the carbon dioxide process was used; 18:8 steel was rough turned at 30 sfm and finished at 900 sfm; milling operations on nickel steels have been held to tolerances of 0.0004 in. in commercial production. Success has been reported also in machining several high strength titanium alloys which are difficult to machine by ordinary methods.

Carbon dioxide cooling has also been used in the grinding of carbide tools. These tools are usually ground dry on silicon carbide wheels. During grinding care must be taken to prevent over-heating and periodic slow-cooling is required. Grinding with a carbon dioxide coolant is reported to improve surface finish of the tool, decrease wheel wear and reduce grinding time required to dress the tool.

Other Applications

Sub-zero treatments are also being explored for other applications. The removal of burrs from soft materials such as rubber is a difficult problem. By chilling the rubber with solid carbon dioxide, deburring has been accomplished successfully by barrel tumbling. In another investigation, strength and hardness of stainless steel has been improved by refrigeration with liquid nitrogen followed by rolling or forging at sub-zero temperatures.





Glass-Reinforced Plastics

by Philip O'Keefe, Associate Editor, Materials & Methods

MATERIALS & METHODS MANUAL No. 91

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and applications.

FEBRUARY 1953

The reinforced plastics discussed here are the low-pressure laminates—mainly glass-reinforced polyesters—used in radomes, boats, automobile bodies, metal forming dies, aircraft ducts and electrical apparatus. These materials are new, well glamorized and much misunderstood. In spite of metal-like strength properties, they are not substitutes for metals. Reinforced plastics are finding their own uses. This Manual gives the prospective user information he needs on:

- **Resins and Reinforcements**
- **Molding Techniques**
- **Properties**
- **Part Design**
- **Applications**

Since 1944, reinforced plastics, especially glass-reinforced polyesters, have been widely publicized. Glass-plastic car bodies recently made news, as did the use in Korea of body armor of the same material. Some reports about reinforced plastics have been fanciful and tend to glamorize the material. There are, however, many substantial applications now in production or under development.

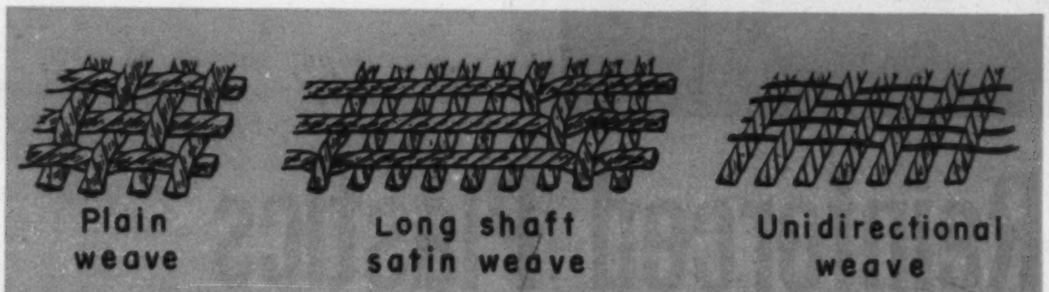
An authoritative definition of *reinforced plastics* is hard to find. In a broad sense, the term covers any mixture of a plastic and fibrous material. Fibers give strength, while the plastic makes the material moldable and stiffens the fibers in the finished material. A rough analogy is reinforced concrete—concrete contributes to compressive strength, stiffness and body, and steel bars take tensile loads.

There are many types of reinforced plastics using glass, cotton, rayon, nylon, asbestoes and paper as reinforcing materials. Reinforcements may be cloth or merely random fibers. Thermosetting phenolic, melamine, silicone, epoxy and polyester resins are used. Most widely used are phenolics and melamines, press molded at relatively high pressures into the so-called high pressure laminates. Another type is molded under low pressures (defined here as 300 psi or less) or no pressure at all. Low pressure laminates are mainly polyesters, although silicone, phenolic and epoxy plastics have been used. Although paper, cotton and other materials have been tried, glass fiber and fabric are the usual reinforcements in low-pressure laminates.

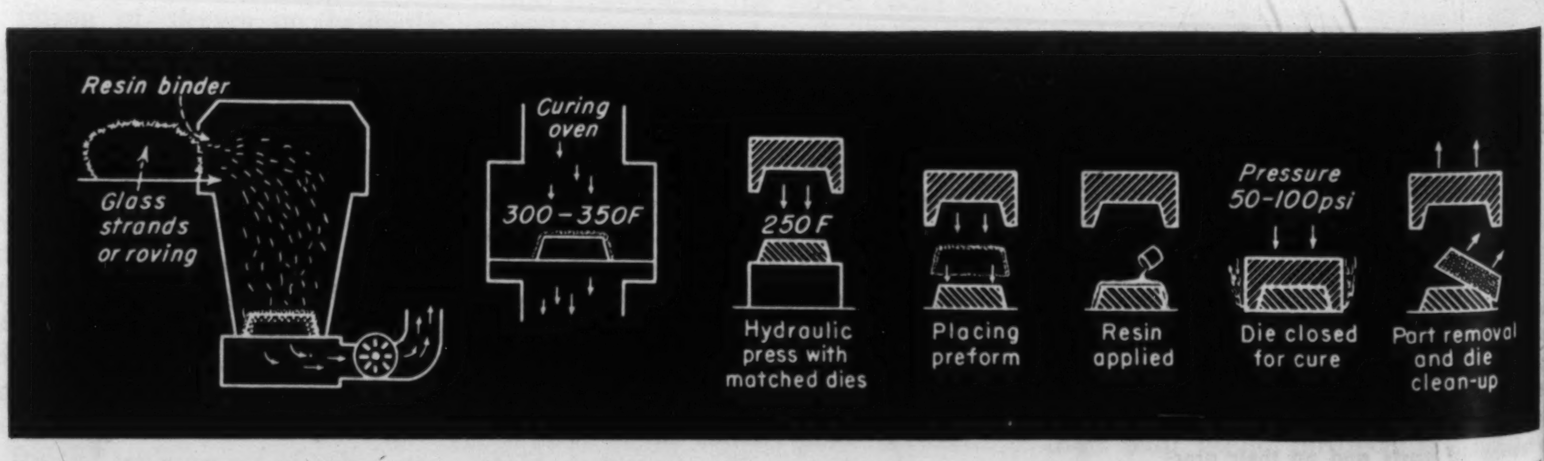
Preform for junction box on B-47 jet bomber is removed from wire mesh. (Boeing Airplane Co.)

This Manual will be confined to the low-pressure laminates. While the dividing line is drawn on molding pressures, the important criterion is applications. In the rest of this Manual the words "reinforced plastics" should be understood to mean only the low-pressure laminates.

These reinforced plastics are new engineering forms as well as new materials. Their value lies not only in properties of the materials, but also in fabrication methods used and part sizes and shapes made. Some polyesters, for example, can be poured into molds or applied to glass cloth or mat and cured with no pressure. No solvent is required to put the resins in liquid form; no volatile constituents are driven off in curing. Thus, no pressure is required. Also, no great strength is required in molds, and part sizes are not limited by press capacity. Large boat hulls molded in reinforced polyesters could



Cloths are classified by weave. Satin fabrics give stronger laminates than plain weave. Unidirectional fabrics give maximum strength in one direction. (Owens-Corning Fiberglas Corp.)



Utility box is made with preform reinforcement. In this typical case, preform binder is cured in 40 sec, and the resin-glass part itself cures in 120 sec. (Owens-Corning Fiberglas Corp.)

not be made in one piece with any plastics which required press curing. Reinforced plastics are not cheap. Sound uses are determined by balancing cost against the valuable combination of properties the materials have. Outstanding properties are:

1. Strength. Tensile strength to weight ratio is claimed to be greater than with any other structural material.
2. Electrical Characteristics. They are nonmagnetic and electrical insulators, and do not stop radar waves.
3. Corrosion Resistance. They are not attacked by sea water, weathering, mild acids, mild bases, many common solvents and many corrosive chemicals.
4. Colorability. Color can be molded directly into the material.

Large parts, like auto bodies and boats, are built up by hand laying cloth and mat and impregnating with resin. (United States Rubber Co.)

5. Nonstrategic. Nothing used in making them is strategic.
6. Resiliency. Medium impact does not produce dents or damage.
7. Dimensional Stability. Humidity and temperature changes from −60 to 250 F have no lasting effects.
8. Thermal Insulation. Heat transmission rate is low.
9. Metal Inserts. Metal parts can be molded in directly.
10. Cheap Moldability. Large, reasonably complex parts are molded in one piece with equipment that is extremely inexpensive compared to the dies and equipment needed for similar metal parts.

On the other hand, there are also limitations. Low-pressure reinforced plastics are not wonder replacements for metals. Neither are they the easy road to get rich quick making parts without proper equipment and experience. Rather than replace metals, they will open up new specialty markets, at least in the foreseeable future. Relatively low-priced custom-made automobile bodies and machine housings are examples.

In general, to be suitable for these materials, a part must require at least two of the ten properties listed above. If strength, corrosion resistance or good electrical properties alone were required, for example, some other material would probably do the job better.

This Manual must differ from a report on a metal alloy family. Properties of reinforced plastics vary widely, for resins, reinforcements and fabricating methods all have important effects. Therefore, no concrete values can be given for strength, density or corrosion resistance. Also, design possibilities are many and broad, but hard to define. Resins and reinforcements come in many forms, all varying with the manufacturer. The molding techniques depend on the materials and change with the skill, equipment and habits of the molder.

We can only give indications of possibilities. The usual property limits are outlined, design conventions are given and some present and projected applications are presented.

Materials

Reinforced plastics are far from being standardized. Therefore, in order to consider and specify correctly, engineers should be familiar with constituent materials and molding techniques.

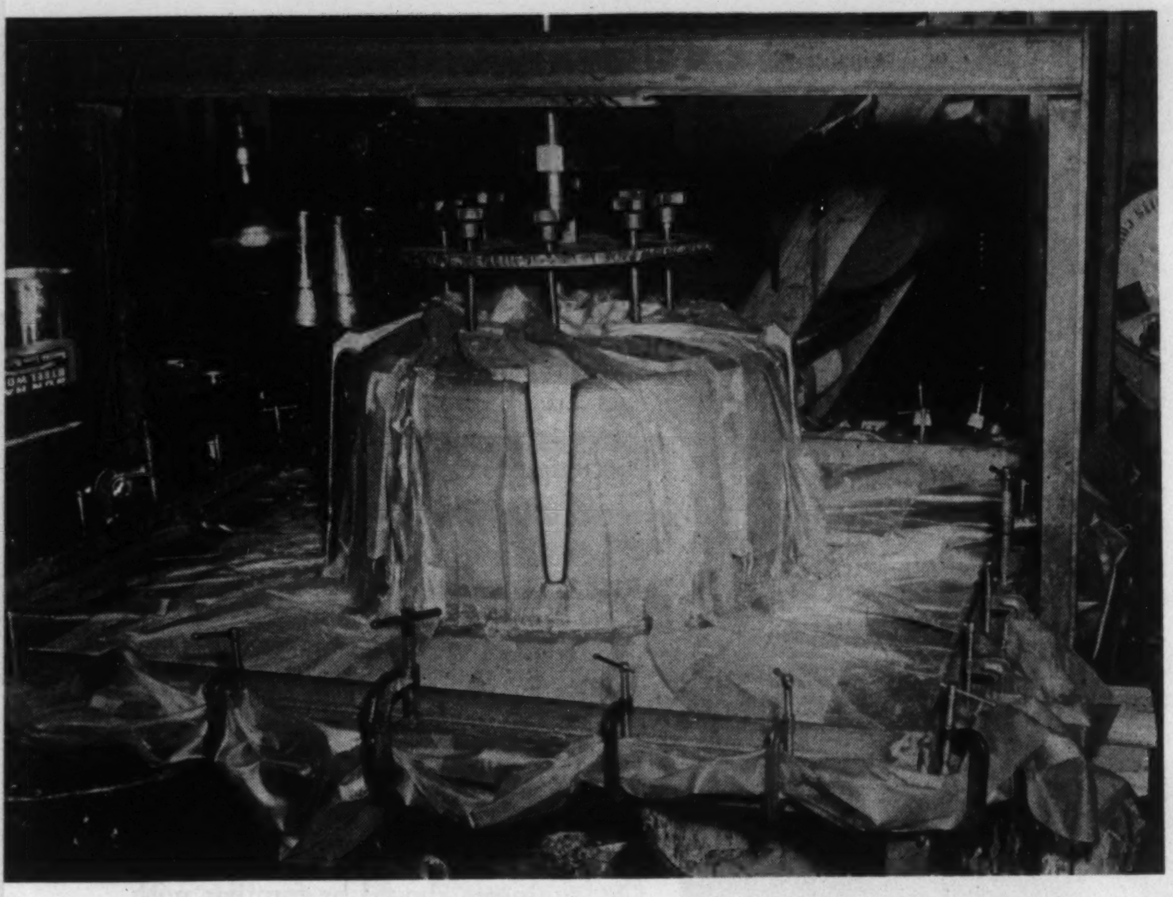
Resins

Polyesters are by far the most widely used resins. Phenolic, silicone and epoxy resins have been tried but are largely experimental now. All these resins are thermosetting. All have good wearing qualities, high strength and resistance to relatively extreme temperatures and chemical attack. While polyesters are surpassed by others on properties or costs, processing advantages outweigh these factors.

Polyesters are used in liquid form. Some suppliers market dry polyesters which are dissolved in liquid styrene before use. Setting, or polymerization, is started by catalysts added just before the liquid resins are put into a mold. Heat speeds up cure. Choice of catalyst depends on curing temperature.

Cured resins vary from soft and flexible to hard and rigid. Their electrical properties and chemical resistance are excellent, cured dimensions are stable, and a wide range of colors is possible.

Two important considerations in formulating polyester resins are shelf life and get time. Shelf life is the time the resin remains stable after being prepared for use. Get time is the time it takes to set to a gel under molding conditions. Catalyst type and amount greatly affect both these characteristics.



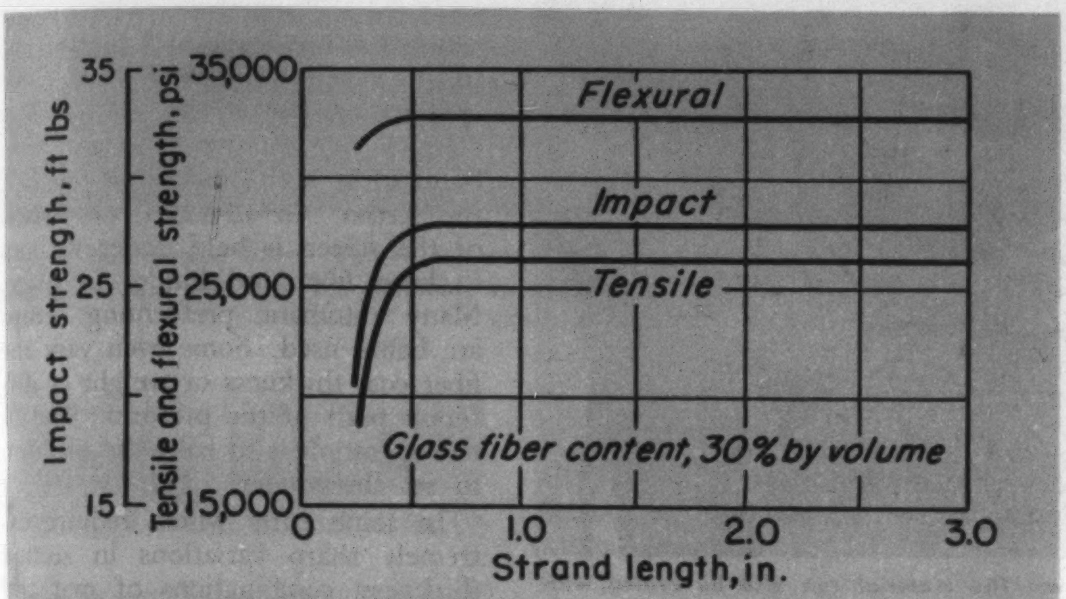
In vacuum bag molding, cloth is laid over a form and impregnated with resin. The entire layup is covered, sealed and depressurized by a vacuum pump. Heat may hasten cure. (The Glastic Corp.)

Viscosity and reactivity of polyester resins can also be varied. Viscous resins have good lay-up tack, increase film thickness in dip coating and laminating, give more stable suspensions and decrease flow before gelation. Low viscosity resins give faster penetration and impregnation, are easier to mix with catalysts, pigments and fillers, and free themselves of air bubbles quickly. Resin reactivity controls cure speed, heat of reaction and finished properties. In general, rigidity, heat-distortion point, heat resistance, shrinkage and dimensional stability of the finished property increase with resin reactivity. Casting, for example, requires low activity resin for low exotherm, low shrinkage and high impact strength. Postforming requires low heat-distortion temperature, and hence less reactive resins. More reactive resin, with high distortion point, is used when it is necessary to quickly remove molded parts from hot molds without any distortion.

Resin selection also depends on size and thickness of parts, type and

Simple, shallow parts with filletted corners not needing close dimensional tolerances are molded by drawing resin impregnated cloth or mat into the mold. (Republic Aviation Corp.)

amount of fillers, temperature and heat dissipation rate of molds, and type and amount of catalysts. Basic commercial polyester types are: rigid, flexible, high heat distortion, low heat distortion, fast get time, slow get time, and fire resistant. Combinations are blended for special applications. Final resin choice often depends on molding experimentation.



Molding strengths are independent of glass-reinforcing strand length between 1/2 and 3 in. For handleability, 2-in. strands are usually used. (Owens-Corning Fiberglas Co.)

Epoxy resins, like polyesters, cure with little or no pressure. Their great adhesive powers give good bond between the plastic and glass fibers. Epoxy-glass materials are, therefore, stronger than polyester laminates. Chemical resistance is also better in some cases, especially with alkalies. Epoxies are 50 to 100% more expensive than polyesters, however. High adhesive power is also a disadvantage in making it difficult to separate finished products from their molds.

Silicones are promising for parts subject to elevated temperatures. Experiments on complex parts molded at 15 psi is encouraging. Silicones retain strength for long periods at 500 F, and for limited periods at temperatures up to 900 F. Resins are quite expensive, however.

Work is also being done with glass-reinforced, low-pressure phenolics. Their properties are similar to polyesters, except for electrical properties, where polyesters hold a definite advantage. Phenolics are considerably cheaper than polyesters and have better properties at elevated temperatures. The drawback to phenolics has been the high molding pressures required for sound parts, and the volatile compounds given off in curing. Several new phenolic compounds that cure at low pressures have recently been introduced, however. Northrup Aircraft engineers recently predicted that glass-phenolic, rather than glass-polyester, would be used in future supersonic airplane skins.

Fillers and Pigments

Commonly used fillers include products consisting mainly of clay, calcium carbonate and aluminum silicate. They give three advantages—improved surface finish, higher physical properties and reduced costs.

Polyesters have high cure shrinkage. This may produce a slightly raised fiber pattern on some surfaces, as well as craze marks or cracks in resin-rich areas. Inert fillers reduce shrinkage, so that crazing can be eliminated and a smooth, even surface obtained.

Certain physical properties can also be improved. Water absorption may be cut one-third, giving better wet strength. Flexibility is modified and finished parts are more rigid. Strength is increased slightly by filler concentrations up to 40% by weight, but larger percentages decrease strength. Chemical resistance is usually unaffected. Resin and filler manufacturers should be consulted when chemical resistance is of prime importance, however.

Most fillers cost less than polyester resins. Concentrations up to 50% by weight are used to extend resins. Specific gravity is increased by fillers. Since some fillers absorb resin in large quantity, a given filler weight concentration does not necessarily give a corresponding volumetric extension.

While the basic resins are clear, polyesters can be pigmented to any color from black to white. Organic, inorganic and metal oxide pigments are used. The pigment chosen must fit the resin, since some pigments accelerate or slow up resin cure.

Reinforcements

For all practical purposes, the materials we are covering here are exclusively reinforced with glass fibers. Paper, cotton and asbestoes have been tried experimentally, but glass has the best combination of strength and permanence. The various forms in which glass fibers are available fill the needs of most of the low-pressure laminates now being made commercially. The forms available are cloth, mats, glass roving, and preforms. The type of glass reinforcement chosen depends more on production problems and parts shapes than on the physical properties required in the part.

Cloths are classified by weave. In plain cloths, each warp and fill yarn passes over one yarn and under the next. Satin fabrics, most satisfactory in heavier grades, are made so that each warp and fill yarn goes under one and over seven yarns. These eight shaft satins give greater strength in laminates than plain weave fabrics. A third variation is unidirectional fabric. These are made with strong warp yarns and relatively few, weaker fill yarns. Such a construction gives maximum strength in one direction.

Glass is also available in mat form, which is cheaper than cloth. Mats are made of short fibers, pressed in layers and held with plastic binder compatable with the resins used. Mat is used to reinforce flat sheet and relatively shallow drawn or embossed parts.

A third form is glass roving. This consists of long, continuous strands. There are no cross threads. Roving is used as a reinforcement in a few special products.

The fourth type of glass reinforcement is preforms. These are made by preshaping fibers to the contour and thickness they will have in finished parts. Preforms lend themselves to complex pieces, where tailoring of mat or cloth would be

Panels cut easily with shears or standard saws. The material can also be drilled with regular tools and fastened by bolts or adhesive. (Alsynite Co. of America.)

wasteful. Parts with deep draws, severe flanges or heavy embossing are typical. Undercut pieces are not practical.

To make a preform, roving is cut in ½- to 2-in. lengths by a special machine, fed into an air stream, stripped of static electricity by an electronic field or a steam jet, mixed with liquid or powder binder and collected on a preform screen. The screen has the shape of a die for the finished part. Binder may also be sprayed on the screen as the fiber collects. An alternate method is to hand spray both binder and fiber on the screen. In all cases, the inside of the screen is held under vacuum to keep fiber and binder in place. Many automatic preforming setups are being used. Some even vary the fiber coat thickness or weight at different parts of the preform. The final operation is to bake the preform to set the binder.

In some parts which require extremely sharp variations in section thickness, combinations of mat and preforms are used.

Machining in Brief

Blanking and Shearing: **Press capacity is approximately one-half that required for metal. Edges are sharp with stock up to 3/32 in., fair up to 5/32 in., acceptable to ¼ in. Die clearances should be half those specified for steel. Shear gibs should be snug and blades sharp. It is not necessary to pre-heat the stock. Punched holes are smaller than the punch by 0.002 to 0.010 in., depnding on thickness and diameter. Blanked pieces will be larger than the die by 0.001 to 0.005 in. Stripping mechanisms requires two to three times the loading used for steel blanking dies to overcome tendency to grip extended punches. Die life between sharpenings is about one-half that for steel and three-quarters that for phenolics.**

Drilling and Tapping: **Rapid operation is achieved with much less power than for metals. Smooth holes are free from chipping and strong threads (one-third the strength of steel) can be obtained. Holes tend to be larger than the drill by about 0.003 to 0.005 in. (more if not well guided). Drill and tap wear are quite rapid on first few pieces, after which it tends to become stabilized. Carbide-tipped drills should be used in solid fixtures for production drilling. Tapping must be done carefully to avoid false cutting and severe weakening of threads. Automatic feed is essential on production work. Wet operation greatly prolongs tool life and eliminates dust. Vacuum dust removal is essential for dry operations on production scale. Drilling parallel to laminations must be done cautiously to avoid delamination, just as with phenolic laminates. Drill should be kept sharp and feed should not be forced. Faster drilling can be accomplished when it is possible to clamp opposite faces tightly.**

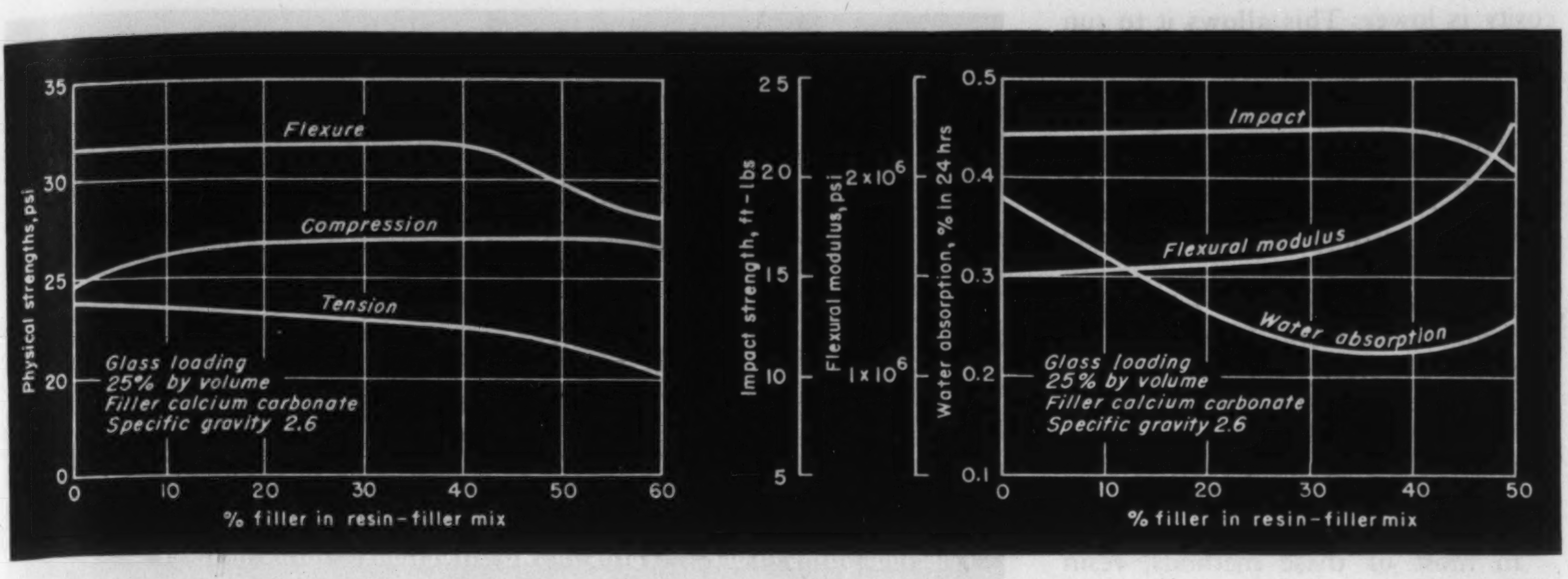
Band Saw Cutting: **Smooth, accurate edges and fast cutting are obtained at extremely high blade speeds (5000 to 10,000 ft per min) in equipment such as Do-All Zephyr. Satisfactory edges requiring only light benching operations can be obtained at ordinary saw speeds. Very low blade speeds (300 to 400 ft per min) are recommended for longer blade life with standard machines. Standard coarse tooth metal cutting blades are satisfactory. Wavy or raker tooth types are recommended. Dust should be removed with vacuum pick-up where production operations are involved. Blade teeth will lose initial keen edge in first few inches of cut so that the saw is no longer useful for metal cutting. It will continue to cut satisfactorily for glass laminates for an hour or more of operation.**

Rotary Cutting: **Clean, smooth edges are easily obtained at high speeds. Wet cutting is far superior to dry. Greater speeds are possible, less power is required, and the dust removal problem is eliminated. Abrasive wheel cutting is faster than diamond or carbide blade cutting, and the cost of blade maintenance is appreciably lower. Rigid work support and wheel mounting are essential with an abrasive wheel to avoid hazardous and expensive blade breakage. Adequate safety hood must be provided. Diamond-edge stainless steel blade is recommended where the conditions prohibit use of abrasive wheel. Carbide-tipped saws will work satisfactorily for dry cutting. Sawing speeds are equivalent to those for phenolic laminates; much higher than for metal. Carbide dry cutting blade life will be about one-half that with phenolics.**

Milling and Lathe Operations: **Clean, smooth, accurate surfaces can be obtained at high speeds. Speeds and feeds recommended for brass are most satisfactory. High clearance and negative rake should be used on tools. Tools must be kept sharp to avoid crowding pressure against cutter with resultant inaccuracies and tendency to delaminate where cutting edge rises across the laminations. Carbide or diamond tools give better life than high-speed steel.**

Routing: **Routing is faster and more acurate than jig or keyhole sawing for medium-run cutting of irregular holes. High speed, low maintenance are achieved in production edging. Routing gives clean, accurate surfaces in edging. Bench filing is required after routing large holes. Routing must be done dry; dust should be removed. Carbide bits are essential.**

(Glastic Corp.)



Properly incorporated fillers improve surface finish and physical properties and reduce material costs. In general, physical properties tend to increase with filler concentrations up to 40%, after which they drop off. Chemical resistance of laminates is generally not affected by filler. (Owens-Corning Fiberglas Co.)

Molding Methods

Molding methods depend on part size and shape, properties desired and planned production quantity. Reinforcements, and to a lesser degree resins, are chosen to fit molding methods.

Matched metal die molding is widely used for long production runs and for close tolerance parts. Molds are heated by steam, hot water, or more rarely, electricity. The preform, cloth or mat is put over the die. With complex parts, pieces can be cut from multiple layers of mat or cloth, and pie sections can be removed to fit deep ribbed sections. Trial and error may be needed to find the right cutout shapes. Pieces can be assembled on a layup jig, and stapled together to hold their shape. Layup dummies shorten production cycles, since the molds do not get a chance to cool. Lap joints in intricate layed-up cloth mat parts may cause section nonuniformities, however.

After the reinforcement has been put over the die, the carefully measured required quantity of resin is poured over it. Resin quantity is calculated on a weight ratio basis from the weight of the reinforcement. In some cases, reinforcement is supplied already impregnated with resin, so that the molder merely puts the glass in the heated molds.

The dies are closed slowly to avoid disturbing the reinforcement or entrapment of air bubbles. Cure times vary with mold temperatures, resins and part section thicknesses. After curing, dies are opened and the part is removed by rubber section cups, air ejection or slip rings. If distortion is noticed, parts are put in cooling jigs for permanent setting. Finally, flash is removed from edges. If the part is to be painted, it is cleaned with acetone and sanded to remove lubricants.

The same techniques are used for draw molding thin parts. Here several layers of impregnated mat or cloth are drawn down into the mold as it closes.

Any type of press capable of exerting 150 psi on the required projected area can be used. Pressures up to 300 psi are used on hydraulic presses.

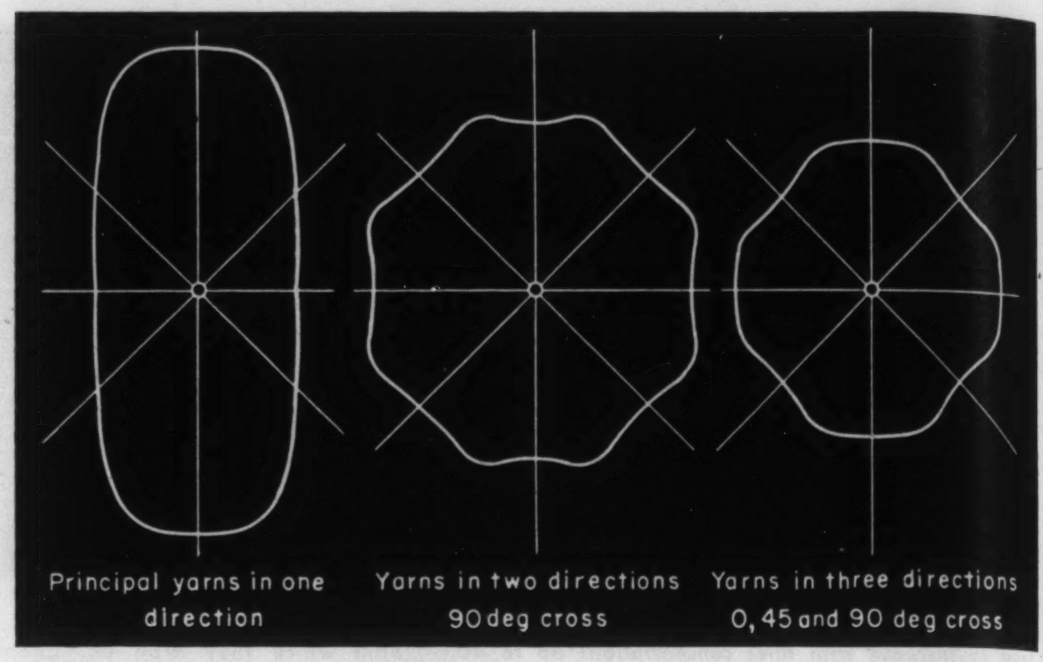
Die material depends on surface desired, production run length and complexity of parts. Tool steel, Kirksite, aluminum and Meehanite cast iron are most commonly used. Kirksite is cheapest, is cast to close tolerances and scraped clean so that little machining is needed. Use only under low temperatures and pressures and for short production runs are disadvantages of Kirksite. Aluminum, though more expensive, allows higher temperatures and pressures and longer production runs. Meehanite, a fine grain cast iron, can be flame hardened around die edges to cut off flash. It is more costly than either Kirksite or aluminum, gives high gloss surfaces, and lasts almost indefinitely in quantity production. Tool steel is the most expensive die material, and the best. It can be polished to mirror finish to give excellent part release. Hard chromium plated steel dies give even better finish and part release. It should be noted, however, that part finish also depends on die temperature; smoother surfaces are obtained with hotter dies.

Where close tolerances are not required, production is not high enough to justify matched metal dies, or where parts are too big or complex to make with machined metal dies, bag or contact molding can be used. The same types of reinforcement can be used, although hand-layed mat and cloth are more usual than preforms. There is no male die in this work. The reinforcement can be impregnated with resin before or after it is put into the mold. In contact molding, the glass is then rolled to eliminate air bubbles and to press the layers together. In bag molding, a thin vinyl blanket is placed over the resin-impregnated reinforcement in the mold. The edges of the blanket are clamped to each other or to a metal backing. This makes an air-tight enclosure, which is evacuated so that the vinyl presses down evenly on the whole surface. The part is cured in an oven. Thickness tolerances are wide with contact and bag molding, and surfaces are much rougher than with matched metal dies.

Two different types of mat and preforms are used. These are classified by the binder resins. Highly soluble binders are used for parts cured at room temperature or relatively low temperatures. These binders dissolve in the laminating resin to some extent. This allows the mat or preform to take the required shape without great pressure. Skylights, boats, automobile bodies and a great many phototypes use high solubility binders. Heated, matched metal molds require low solubility binders. The resin is hotter here, and its viscosity is lower. This allows it to run through the reinforcing fibers and fill the mold cavity. The low solubility resin remains firm enough during molding to prevent the resin from tearing or washing the glass fibers out of position to leave resin-rich, weak areas in the finished product.

Work has been done with postforming. Some resins have the property of softening somewhat when heated after molding. In this condition, some forming can be accomplished before the part cools to final set. This process is still pretty much in the development stage.

In most of these methods, resin and reinforcement are mixed in the mold. There is one other technique, however, in which mixing is done before the compounds get to the mold. Polyester-glass molding compounds are still comparatively new and commercially small. Their importance is growing. These compounds, composed of polyester resin and glass fibers up to 2 in. long, are suitable for compression, transfer and injection molding. With the right techniques, good distribution of the fibers can be maintained throughout the part. With a glass content of only 30% by weight, parts molded by these methods are not as strong as conventional glass-reinforced polyester pieces. More intricate shapes can be made at lower costs, however. Electrical properties are not harmed by the increased resin content, and many electrical parts are made in this way. Glass also gives dimensional stability. [See *Materials & Methods*, Jan. 1953, p. 87.]


Principal yarns in one direction
Yarns in two directions 90 deg cross
Yarns in three directions 0, 45 and 90 deg cross

Diagrams show directional strength control possible with cloth laminates. Unidirectional cloth can be laid-up with principal yarns (warp) parallel, crossing at 90 deg, or in a three-way cross. Square woven and satin fabrics may have warps and fills in line or in alternate layers crossing at 45%. (Owens-Corning Fiberglas Corp.)

Properties and Design

Specific property data and hard and fast design rules or conventions are difficult to find, since properties are not well defined and experience in most applications is lacking. Strength, chemical resistance and temperature limits vary with the type and supplier of the resin. Molding variables also have effects. Thus, there are no reliable property charts for finished materials. Even if there were, the absence of practical experience with many products and the absence of good nondestructive testing methods would prevent the engineer from designing to the highest property values. Nevertheless, general property indications can be given, together with such design conventions as have evolved from molding procedures and the present short experience.

Cooperation between molders, designers and users is essential. Experience and experiment are the only reliable guides in deciding on reinforced plastics for a piece and in designing the piece. Molders must be given complete information on how and where a part is to be used, and detailed specifications should not be set up until some actual parts are made and tested.

Mechanical Properties

Within practical ranges, tensile strength, flexural strength and impact strength vary directly with the percentage of glass in the laminate. This is true of mat, preform and cloth reinforced materials. Within ½- to 3-in. limits, fiber length has no effect on flexural, tensile or impact strength.

Unlike properly molded mat and preform reinforced parts, cloth reinforced products may have definite directional properties in the flat direction. Plain weave fabrics give a uniform strength pattern through 180 deg. With contact molding and vacuum laminating, air bubbles are easy to remove and a homogeneous, strong product is obtained with plain weave fabrics. Long shaft satin weave fabrics are best used where light weight and high strength in all directions is required. With thick satins, high-strength laminates are easier to make, since layup costs are reduced.

Unidirectional fabrics are recommended to give maximum strength in one direction. They are valuable where the loads can be definitely established for the finished part. Unidirectional fabrics can also be used to give additional strength or impact resistance in local areas. They give extreme strengths with minimum weight. Because unidirectional fabrics must be cross-laminated, however, they raise costs by increasing hand labor involved.

The highest over-all strength properties are found in the thin glass cloths and in laminates employing them, at least on the outer stressed surfaces. Over-all strength decreases as fabric thickness increases. The diminishing effect of increased thickness is greatest in compression. Impact strength, however, varies directly with the thickness. That is, thicker fabrics have higher impact strengths.

Many parts are built up of several layers of mat and/or cloth. Since each type of cloth has its own modulus and strength qualities, uneven cooling after molding could conceivably cause warping. If the layers are put on so that the reinforcement is symmetrical around the neutral axis, this danger is removed. Such an arrangement is important when dimensional stability is desired.

One problem is low modulus of elasticity in flexure. To get the same resistance to bending as steel, material must be over twice as thick. This reduces the weight advantages and increases cost. Where flexural loads are involved in parts requiring minimum weight, sandwich construction can be used. The laminated skins are fully stressed in tension and compression and the core serves primarily as a spacer. Properly designed, sandwich construction offers maximum rigidity with minimum weight. The primary limitations are that they possess low impact resistance because of stiffness and thinness of the surface laminates, and they are relatively expensive to fabricate because of the hand labor involved.

Table 1—Properties of Cloths

Cloth	Yarn	Construction	Thickness, In.	Weight, Oz/Sq Yd	Break Strength, Lb/In. Width	
					Warp	Fill
SQUARE-WOVEN FABRICS						
A	450-1/2	40 x 39	0.003	2.09	100	70
B	225-1/3	42 x 32	0.007	6.0	250	200
C	225-2/5	28 x 16	0.015	12.20	450	350
UNIDIRECTIONAL FABRIC						
D	Warp— 225-3/2 Fill— 450-1/2	48 x 30	0.009	8.90	610	56
LONG-SHAFT SATIN WEAVE FABRICS						
E	225-1/3	57 x 54	0.0085	8.90	310	310
F	225-2/2	60 x 56	0.013	12.40	390	380

Table 2—Typical Properties of Cloth Base Polyester Laminates

Cloth (See Table 1)	Tensile Str., Psi	Compressive Str., Psi	Flexural Str., Psi	Bearing Str., Psi	Shear Str., Psi	Modulus in Flexure, Psi	Izod Impact Str., Lb/In.
A	40,400	36,200	57,100	36,600	18,500	2,860	16.8
B	40,600	25,300	53,200	46,800	19,300	3,340	19.0
C	35,400	15,400	41,100	31,900	18,100	2,360	30.7
D (Parallel)	84,600	47,100	107,400	41,100	26,800	5,370	52.2
D (Cross)	47,800	39,800	68,800	43,300	20,300	2,760	27,600
E	36,800	35,900	61,200	41,600	18,600	3,220	19.3
F	49,400	26,900	57,900	34,300	19,000	3,250	25.4

Data courtesy Owens-Corning Fibreglass Corp.

NOTE: The cloths in Table 1 are typical. The table is not all-inclusive.
The laminate properties in Table 2 are based on a particular resin and cloth finish. They are given for illustration purposes only.

Temperature, Corrosion and Moisture

Strength, including impact strength, improves as the temperature goes down, even down to —110 F. Strength decreases with rising temperature. In air, temperatures up to 250 F can be taken continuously, with intermittent temperatures up to 300 F. Continuous temperature is limited to 180 F in water or alkalies. Resin manufacturers should be consulted for the heat distortion point of each resin, however.

Since glass fibers do not shrink or stretch under moisture change, have a low thermal expansion coefficient, and are strong enough to resist expansion by the resin, laminates are quite dimensionally stable. Thermal expansion of the material is about 16×16^{-6} per deg F. This changes slightly with glass content. It is close to the expansion rate of aluminum alloys.

Thermal transmission rate for male laminates is about 1.5 Btu/hr/sq ft/in./deg F. It increases directly with the volume percentage of glass.

Weathering tests over a period of time equivalent to several years of exposure under the severest conditions have indicated no significant effect on laminate strengths other than a slight yellowing of the plastic material. When immersed in water for 14 days and tested while wet, these laminates retain 80% of their initial dry strength.

Reinforced plastics have good resistance to many corrosive chemicals. Many acids, solvents and weak to medium bases can be handled successfully. An accompanying table lists resistance of reinforced plastics to common chemicals.

Machining, Joining and Finishing

Glass-reinforced polyester can be machined, in general, with standard steel working equipment. They are similar in machining characteristics to canvas-base phenolics.

Joints are made with polyester resin adhesives. Lap joints of 200- to 500-psi strengths can be obtained. These are adequate where prying, peeling and shock are negligible. The only really strong cemented joint is one made by pressing one tube inside another. Before bonding, surfaces should be lightly sandblasted. Bonds to metal are usually poor.

Bolted joints are commonly used when molded sections must be joined. Flanges are reinforced by

Table 3—Physical Property Requirements, Structural Glass-Reinforced Polyester (U. S. Air Force Specification 12049).

Federal Specifications L-P-406 Method No.	Property and Test Conditions	Requirements
*1031	Ultimate strength, flexural, flatwise, psi	45000
1031	Yield strength flexural, 0.2% offset, psi	40000
1031	Tangent proportional limit, flexural, psi	25000
1031	Modulus of elasticity, flexural, initial, psi	2.5×10^6
1011	Ultimate strength, tensile, psi	35000
1011	Yield strength tensile, 0.2% offset, psi	25000
1011	Modulus of elasticity, tensile, initial, psi	2.5×10^6
1021	Ultimate strength, compressive, edgewise, psi	25000
1021	Yield strength compressive, edgewise, 0.2% offset, psi	24000
1021	Modulus of elasticity, compressive, edgewise initial, psi	2.5×10^6
1071	Impact strength, edgewise, notched Izod, ft lb per in. notch	7
2021	Flammability, in. per min (max)	1
7031	Water absorption, max, 24-hr immersion	1.0%
7031	Thickness increase, max, 24-hr immersion	0.5%
1081	Rockwell M hardness	95
	PROPERTIES AT 160 F:	
1031	Ultimate strength, flexural, flatwise	23000
	Modulus of elasticity, flexural, psi	1.9×10^6

** Plus 10% Styrene Monomer.*

extra layers of glass cloth or mat or by metal inserts. These metal inserts can be molded into the material without difficulty.

Surface finish may be somewhat of a problem, particularly where shiny solid color finishes are desired. These materials do not have outstanding abrasion resistance. No finish has yet been developed to give them enough surface hardness to compete with metals in places where abrasion is encountered. Smoothness can be obtained on molded surfaces and cut edges, however, by coating with polyester resin.

Electrical Properties

For electrical applications, the low loss factor, good arc resistance and high dielectric strength at high frequencies of reinforced plastics are valuable properties. According to manufacturers, electrical grades of glass-polyester are competitive in price with cotton filled phenolics, but have greater impact strength, arc resistance, heat resistance, dimensional stability and moisture resistance.

Shapes and Tolerances

There is no size limit on parts. Parts made in matched metal molds are restricted by the size of presses, but bag or contact molded pieces have no such restrictions.

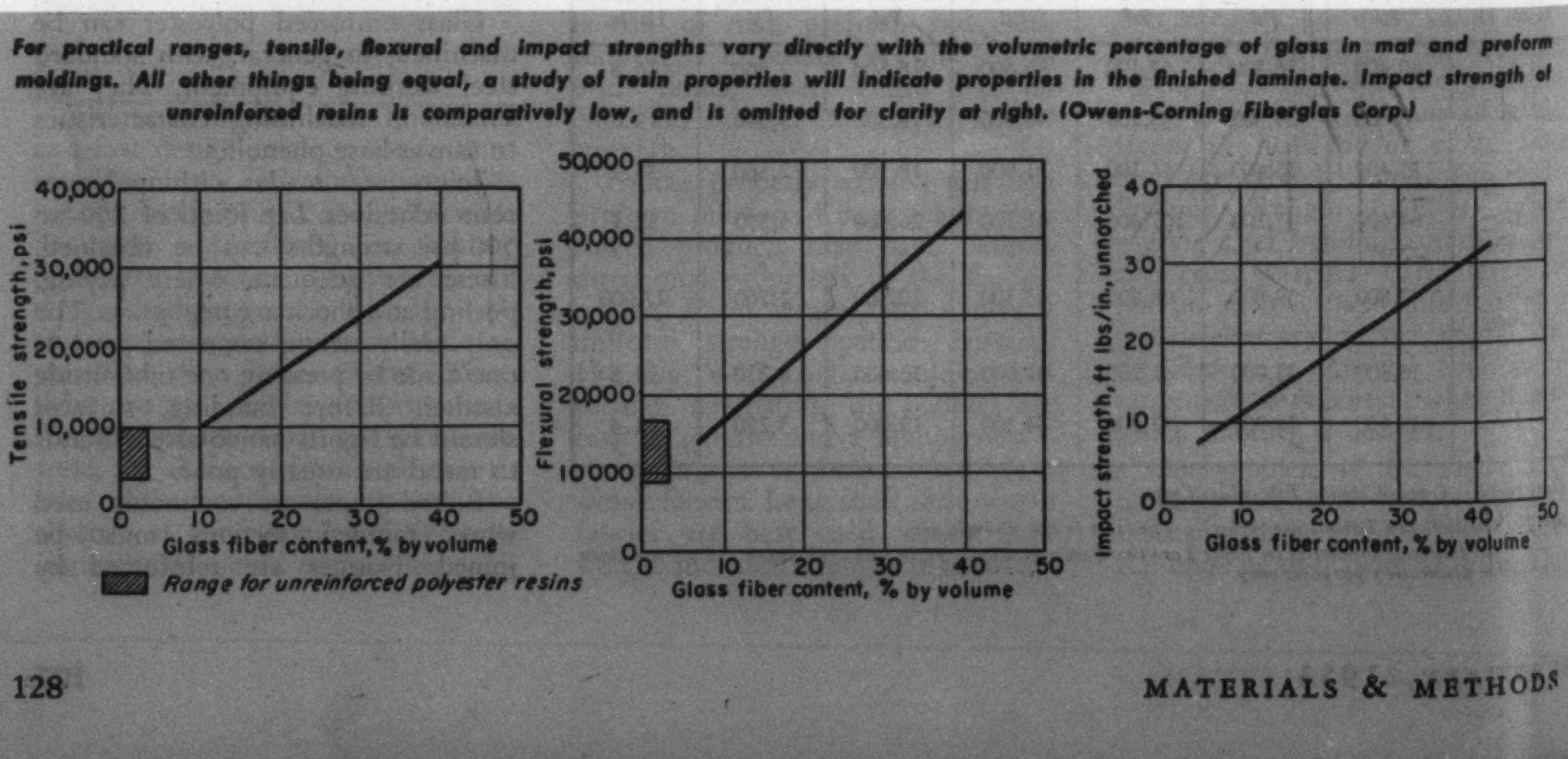
Any shape can be made that can be taken out of a mold. Undercut parts must be made in pieces, for example. It is advisable to keep ⅛- to ¼-in. radii on all corners. Thick sections should be avoided, as should abrupt section changes. Deep indents and ribs can be made if these conventions are followed. Side walls should have a minimum draft of 1 deg for shallow parts and 3 deg for deep parts.

Part tolerances depend on mold tolerances and shrinkage. One molder suggests that 0.1 in. in 24 in. is a reasonable specification. Biggest uncertainty arises from: (1) a molded part shows different shrinkages on each dimension; and (2) these shrinkages are not exactly predictable. Shrinkage on each dimension is very nearly constant, however. Once a mold is made, parts show little dimensional variation.

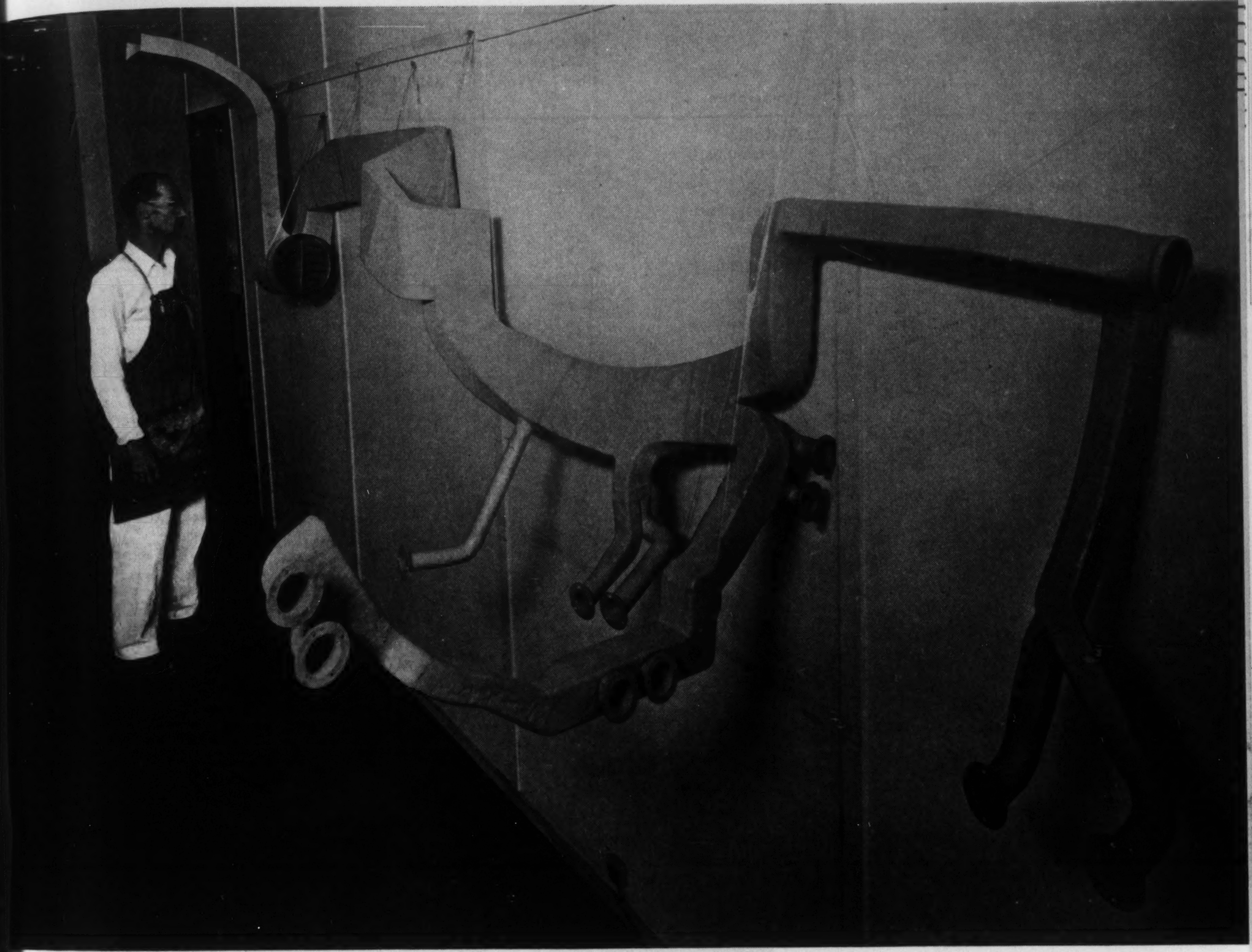
Applications

Over half of the glass-polyester parts now being made are for military applications. It would be impossible to publish a complete list of major applications, even if such a list could be made up. In the following section, a limited number of interesting applications are mentioned. In each case competitive advantages are given. This may give the reader a better idea of the possibilities for reinforced plastics in his own product.

Tanks, pipe, hoods and ducts are made of these materials. The combination of corrosion resistance and

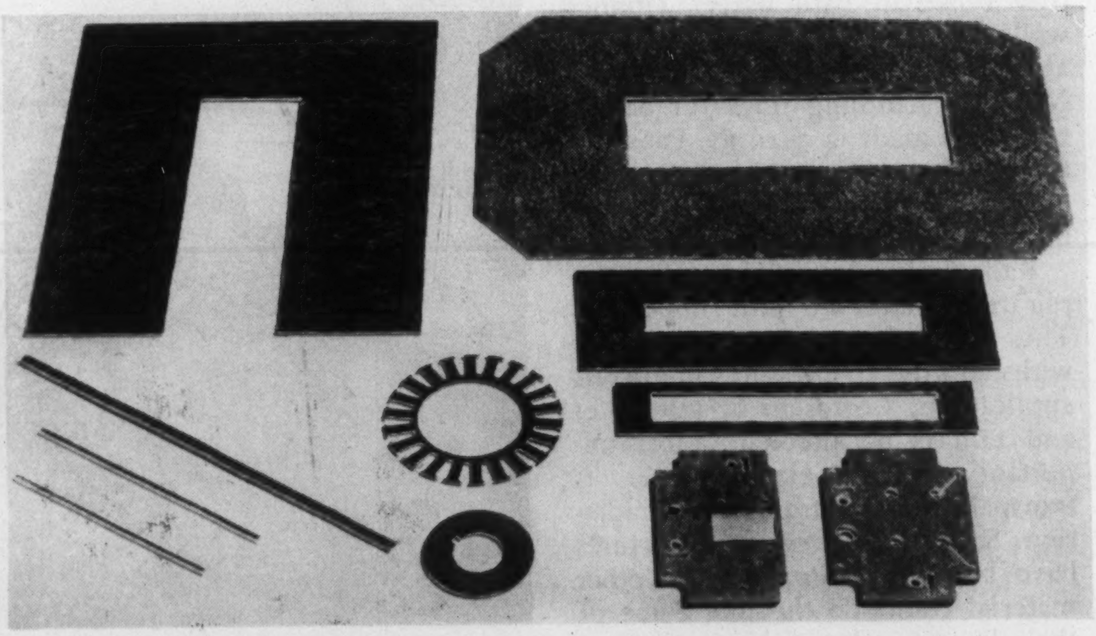


For practical ranges, tensile, flexural and impact strengths vary directly with the volumetric percentage of glass in mat and preform moldings. All other things being equal, a study of resin properties will indicate properties in the finished laminate. Impact strength of unreinforced resins is comparatively low, and is omitted for clarity at right. (Owens-Corning Fiberglas Corp.)



Complex airplane ducting can be molded comparatively easily, without the expensive tools that would be needed for aluminum. Reinforced plastic also saves weight. (Owens-Corning Fiberglas Corp.)

strength is the big selling point. Pressures contained cannot be very high, unless some seepage through the pores can be tolerated. Applications have been made in processing and electroplating in chemical, paper, textile, metal finishing and allied industries. Large duct systems carry away fumes from automatic pickling and phosphating machines. A recent job includes 500-gal tanks and necessary pipe and fittings for a laboratory waste system. Truck water tanks have been successful, with light weight and rust resistance the big advantages. Crude oil tanks, bolted together in sections, resist hydrogen sulfide, salt water and electrolytic action. Equipment which must be cleaned thoroughly and requires an enamel smooth surface is not fair game, however. The glass-plastic sur-



Glass-filled polyester insulating material is cold punched in thicknesses up to 1/4 in. (Glastic Corp.)

Table 4—Typical Corrosion Resistance

Reagent	Temperature	% Change Thickness After 1 Week, %	% Change Weight After 1 Week, %	Visible Effect
Sulfuric Acid	10% Room	+0.23	+0.018	Sl. surface attack
Sulfuric Acid	10% Steam bath	+33.0	+14.8	Badly attacked
Sulfuric Acid	96% Room	—	—	Completely broken up
Nitric Acid	10% Room	+0.28	−1.63	Unchanged
Nitric Acid	10% Steam bath	+1.8	−11.9	Slight attack
Nitric Acid	70% Room	+19.0	+23.9	Badly attacked
Hydrochloric Acid	10% Room	+6.2	−1.57	Unchanged
Hydrochloric Acid	10% Steam bath	+9.5	−6.92	Sl. surface attack
Hydrochloric Acid	36% Room	+2.0	−0.89	Cons. surface attack
Acetic Acid	99% Room	+1.1	+0.75	Slight surface attack
Acetic Acid	10% Steam bath	+20.0	−7.48	Cons. attack soft
Sodium Hydroxide	10% Room	+2.5	−3.77	Sl. surface attack
Sodium Hydroxide	10% Steam bath	+51.0	+29.0	Swollen soft cons. attack
Sodium Hydroxide	40% Room	−0.6	−0.87	Cons. surface attack
Zinc Chloride	10% Room	+0.4	+0.20	Unchanged
Zinc Chloride	10% Steam bath	+1.0	+0.62	Unchanged
Water	10% Steam bath	+2.1	+1.2	Vsl. surface attack
Methanal	10% Steam bath	+1.2	+1.69	Unchanged
Butanal	10% Steam bath	−3.7	+0.12	Unchanged
Butanal	10% Steam bath	+3.6	+2.9	Vsl. surface attack
Ethyl Acetate	10% Room	+3.6	+2.87	Sl. surface attack
Butyl Acetate	10% Room	+1.3	+0.086	Unchanged
Butyl Acetate	10% Steam bath	+11.0	+7.6	Slight surface attack
Acetone	10% Room	+5.7	+5.08	Sl. surface attack
Cyclo Hexane	10% Room	Unch.	+0.09	U. sl.
Cyclo Hexane	10% Steam bath	+100%	46.3	Badly attacked soft
Tetrachlor	10% Room	−1.8	+3.57	Vsl. surface attack
Tetrachlor	10% Steam bath	−0.5	−4.2	Sl. surface attack
Tetra Chlorolirium	10% Room	+1.0	−3.27	Sl. surface attack
Tetra Chlorolirium	10% Steam bath	+7.3	+5.79	Sl. surface attack

Tests made by Shawinigan Chemical Co. on glass-mat reinforced filled polyester resin produced by Molded Resin Fiber Co.

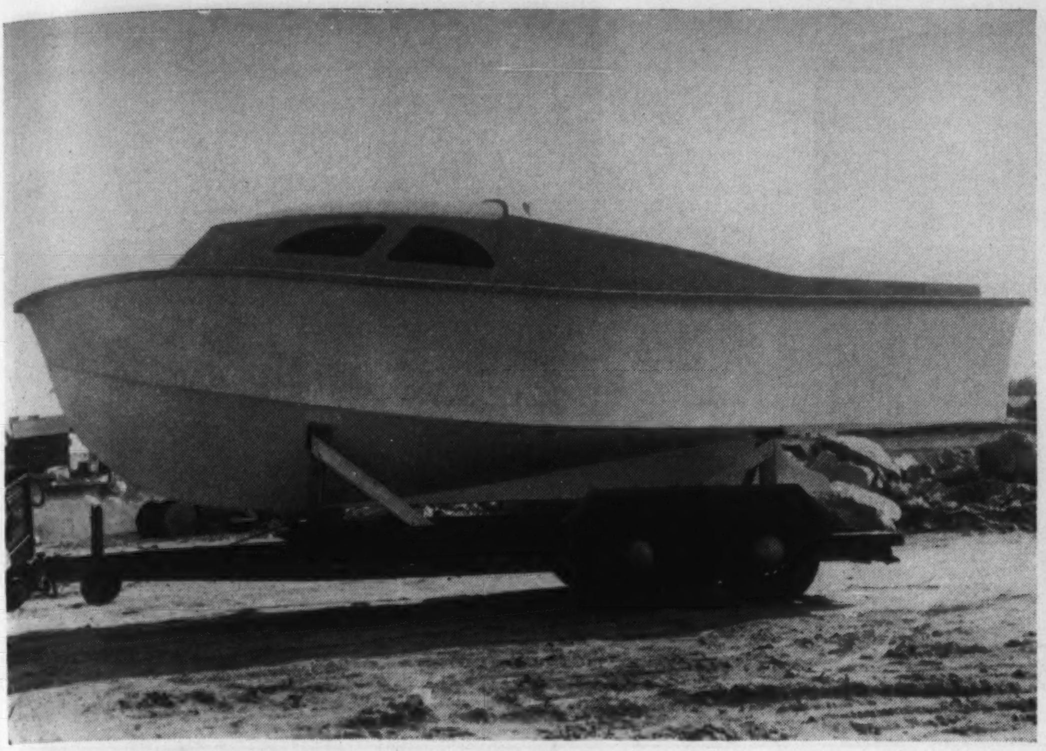
face retains dirt.

Trays and tote boxes made of reinforced plastics are light, strong and chemically resistant. They are easy to make, but cost more than similar metal products. In some cases, glass-plastic has not been durable enough. Deep trays, for example, were made too thick and lacked resiliency so that they broke in hard usage. Thinner walls and metal wire reinforcement at the top edges may be the remedy. Materials handling trays for bakery trucks are made in quantity. Pans and trays for water evaporation and chemical handling are also in commercial production.

Radomes were one of the first applications, and are still important. The material is strong enough to withstand the air pressures in aircraft applications. Corrosion by salt water and rain is no problem. Most important of all, glass-polyester is transparent to electromagnetic radiation. Solid and honeycomb structures have been used. Probably no other material could do the job. Some of the largest glass-polyester pieces made are radomes.

Some work has been done on ma-

Planetorium dome was molded in sections and bolted together. Light weight and easy molding to curved contours are selling points. (Winner Manufacturing Co.)



One-piece boat hulls resist corrosion, sunlight, worms, termites and rot. Light weight and reasonable cost are other advanages. (Beetle Boat Co., Inc.)

Radomes are an extremely successful application. Strong molded reinforced plastic skin is transparent to radar waves. (Owens-Corning Fiberglas Corp.)

chine housing, particularly to replace aluminum castings. A photoelectric engraver cover provides good insulation to the machine, and grounds out electrical interference through a molded-in copper screen. Reinforced plastic cases are being studied by military authorities for nonportable typewriters. These would replace wood and metal at 50% weight saving. Unless weight, electrical insulation or corrosion resistance is of prime importance, however, metal housings will almost always be cheaper.

A big use of glass-reinforced polyesters is in electrical insulation, primarily as a replacement for phenolics. This replacement is strictly on the basis of lower cost and/or better properties. Compression molded parts and parts stamped from sheet are used. The higher cost in relation to canvas and paper-phenolics is offset by greater strength, impact resistance rigidity and by the ability to take higher operating temperatures and temporary overload temperatures without blistering, embrittlement or shrinkage. More vibration can also be taken. Glass-polyester is also easier to punch into intricate shapes than asbestos-phenolics.

Table 5—Typical Minimum Properties of Electrical Insulation Glass Reinforced Polyester

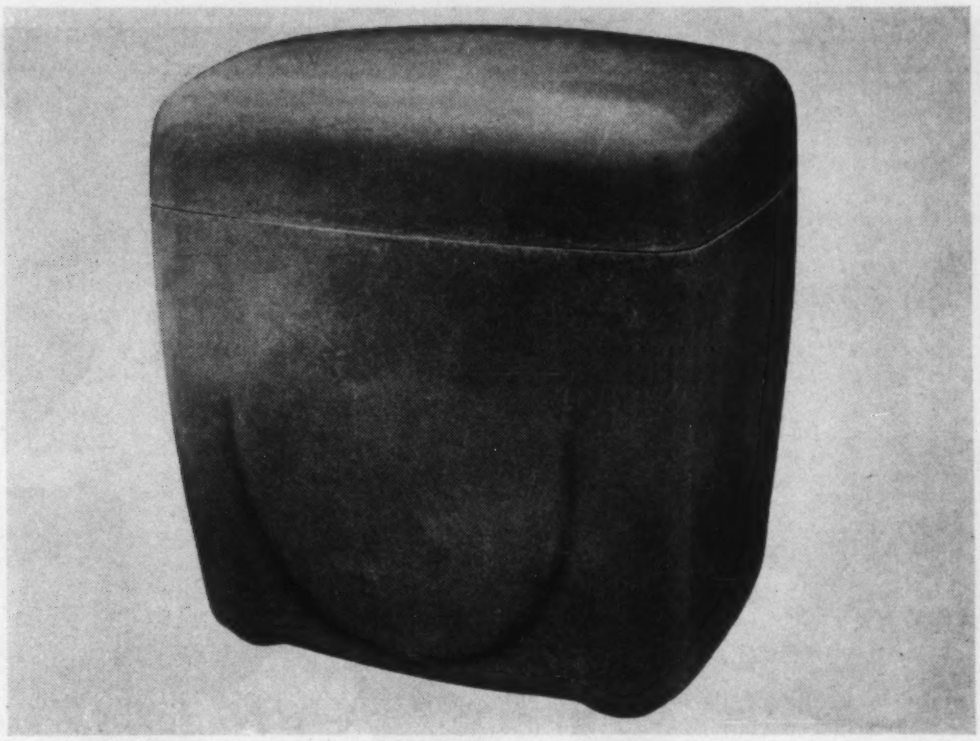
Property	Standard	Flame Resistant
Flexural strength, psi, min	20,000	34,000
100 hr at 302 F	20,000	32,000
Modulus of elasticity, psi, min	1.3×10^6	2.84×10^6
Impact strength, Izod, flatwise, ft-lb/in. min	12.0	19.2
100 hr at 302 F	12.0	25.0
Tensile strength, psi, min	10,000	17,000
Compressive strength, psi, min	33,500	53,000
Hardness, Rockwell M, min	85	90
Water absorption, %, max	0.60	0.75
100 hr at 302 F	1.60	1.75
Shrinkage—100 hr at 302 F, shrinkage shall not exceed 1.0% in any direction.		
Dielectric strength, v/mil, min[2]	300	250
After 100 hr at 302 F	300	250
Arc resistance, seconds, min[2]	125	40
Insulation resistance, after 5 days at 125.6 F+3.6 F	—	5
Warp or twist—standard conditioning and 100 hr at 302 F, shall not exceed the following:		

Thickness, In.	Warp or Twist, % of Length, [1]Max
Over 1/15 to 1/4 incl	1.0
Over 1/4 to 3/4 incl	0.5
Over 3/4 to 1 incl	0.25

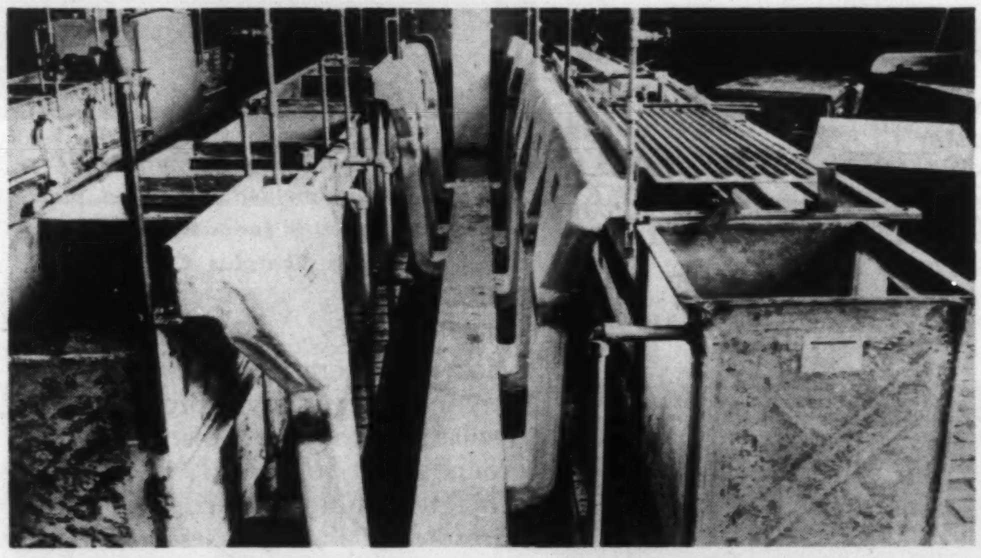
Referee Methods:	
Conditioning	ASTM D229
Flexural strength	ASTM D229
Modulus of elasticity	ASTM D790
Impact strength	ASTM D229
Tensile strength	ASTM D229
Compressive strength	ASTM D229
Hardness	ASTM D229
Water absorption	ASTM D229
Arc resistance	ASTM D495
Dielectric strength	ASTM D229
Insulation resistance	ASTM D257[3]
Shrinkage	ASTM D709
Warp and twist	ASTM D709

NOTES: [1] *Length of dimension along which warp or twist is measured (on basis of 36-in. length).*
[2] *After conditioning for 48 hr at 122 F, unless otherwise indicated.*
[3] *After specified conditioning, test shall be conducted at 125.6 F and 100% R H using tapered pin electrodes and applied voltage of 200 v.*

Adapted from General Electru Co. Specifications



Navy two-piece loudspeaker housing is example of preform molding. The unit out-performs metal cabinets acoustically. (American Cyanamid Co.)

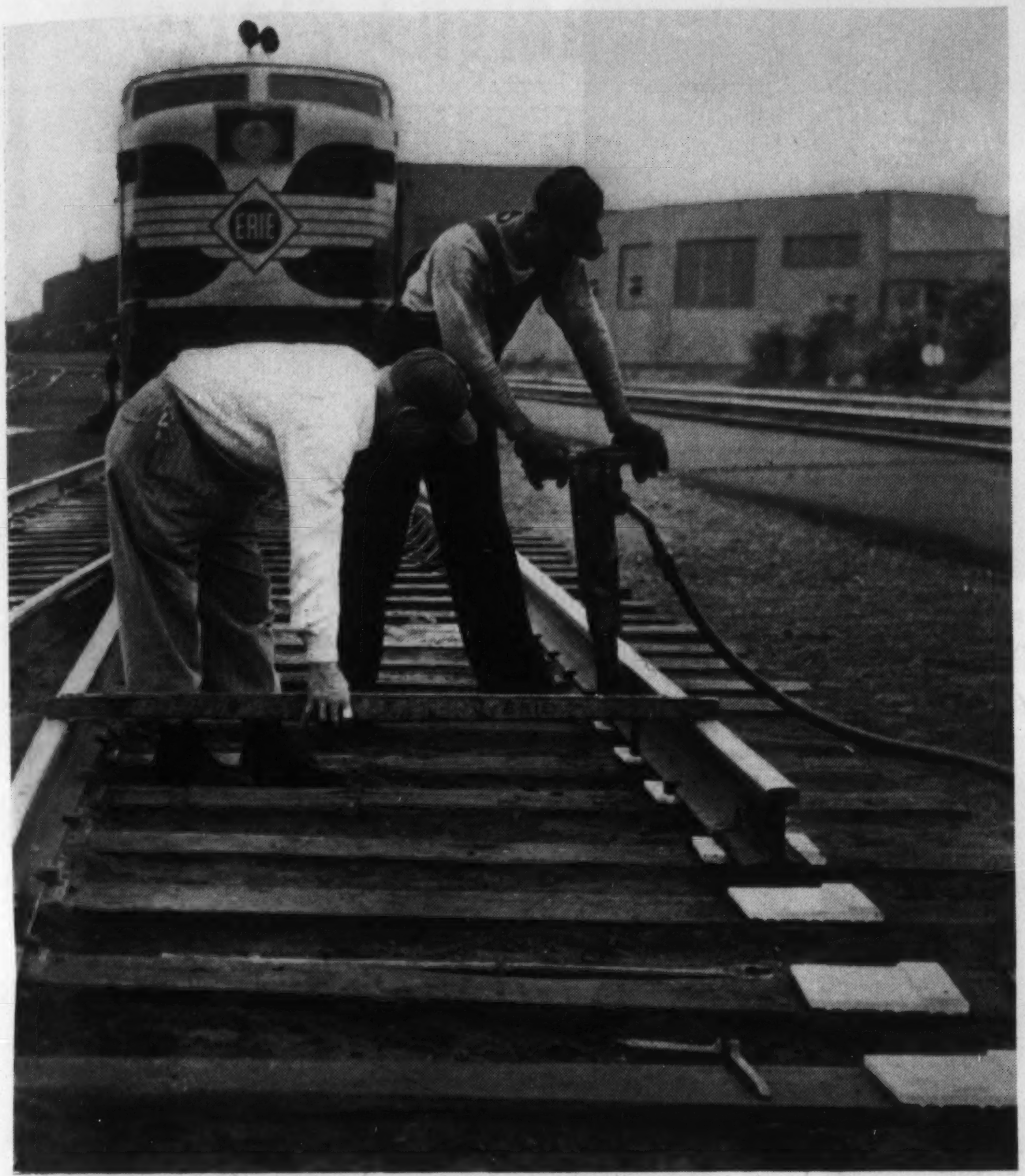


Glass-polyester ducts, hoods and tanks are used in chemical equipment. Corrosion resistance and strength are required. (Chemical Corp.)

Patterns and fixtures for aircraft parts are molded of glass-polyester in intricate shapes quickly, easily and economically. (Republic Aviation Corp.)

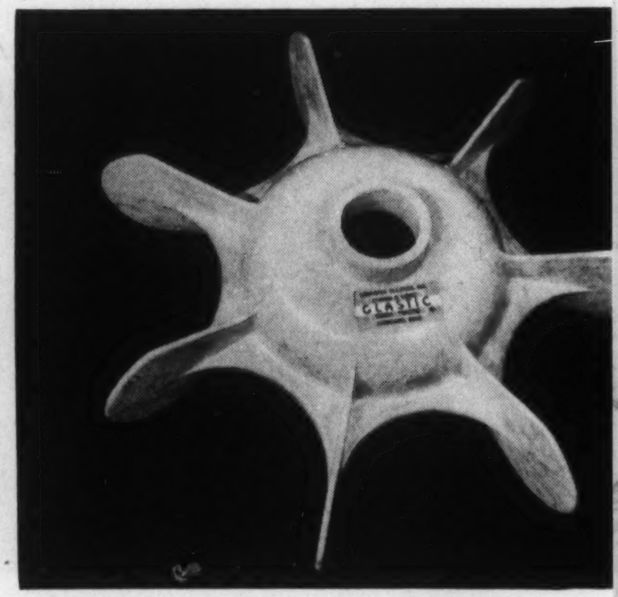
Airplane seat is outstanding for light weight and strength. Cloth and mat reinforcement are used. Riveted aluminum seats were heavier and more expensive. (DeHavilland Aircraft of Canada Ltd.)

In Class B motors, glass-polyester end laminations insulate coil turns without becoming brittle in service. (Glastic Corp.)



Glass-reinforced polyester track rail support plates have the required strength, corrosion resistance and resiliency. (Dynakon Corp.)

Safety helmets and even military body armour have been molded in glass-polyester. Light weight and high strength are valuable in these cases. (Auburn Button Works)



Westinghouse blower fan was switched to reinforced plastic from aluminum, cast iron, malleable iron, and bronze. Low inertia and corrosion resistance are desirable. Cost was lower than for bronze, malleable iron and sand cast aluminum. Costs were about equal for permanent mold aluminum. Unmachined die cast aluminum was slightly cheaper than reinforced plastic. (Glastic Corp.)

In electric motors and generators, slot sticks, slot cell bottom spacers and intercoil separators, armature end laminations, coil end washers and coil head insulation are being converted to this material. Electrical shim stock, electromagnet intercoil spacers, control finger panels, transformer spacers and terminal locks are also good applications. Moisture and tracking resistance are important in these spots. The material is used in chromium plating anti-saggers. Here it resists attack by the bath and retains its strength, rigidity and insulating value.

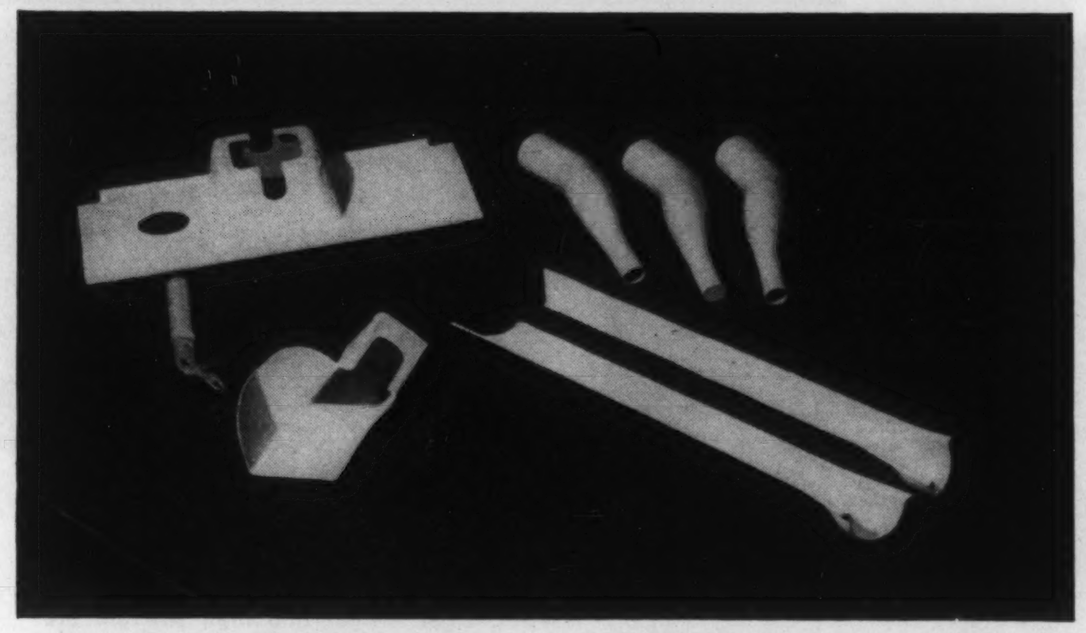
Ducts for the B-47 jet bomber have been molded from preforms. Weight saving was one advantage over aluminum. In addition, molding of the complex duct shapes was easier. Special tools and fixtures would have been needed to make aluminum ducts. Heating and ventilating ducts and the fuel-vent system are now made of reinforced plastic. Junction boxes and most of the safety equipment are other B-47 applications. Other military applications are crash helmets and bullet-proof vests. Strength and light weight are the desirable properties in these products.

Two of the largest fields of application are in furniture and architectural materials. In utilitarian industrial and military shelters like plane housings and refrigerator buildings, light weight, corrosion resistance, strength and, to some extent, heat insulating value are required. In some places unpigmented translucent material is used in windows. A soft diffuse light is admitted and breakage is eliminated. The same properties are valuable in lamp shades. The ability of the material to be molded easily into complex, interesting shapes has encouraged its use in chairs and corrugated and patterned wall panels and screens.

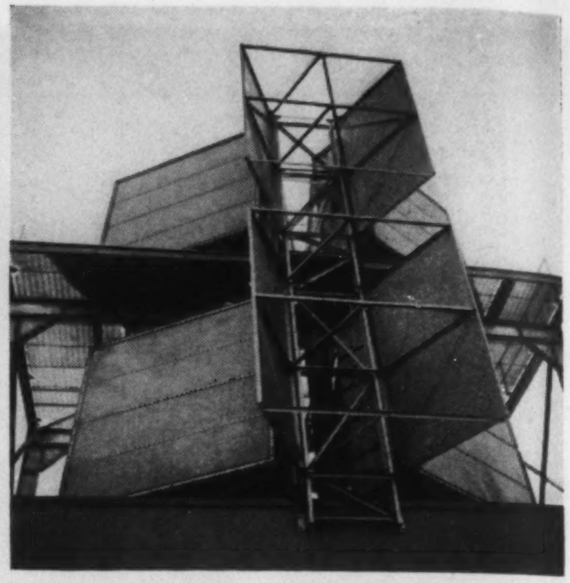
Inner door liners for commercial beverage coolers are being molded successfully. Finishing problems have so far stood in the way of similar domestic refrigerator liners.

A very successful application has been in small boats. The material is impervious to corrosion by salt water, sunlight, worms, termites, barnacles and rot. It can be molded easily into any shape the hull designer wants. The light weight of glass-polyester hulls is also an advantage. Many of these boats are used by civilians and by the armed forces.

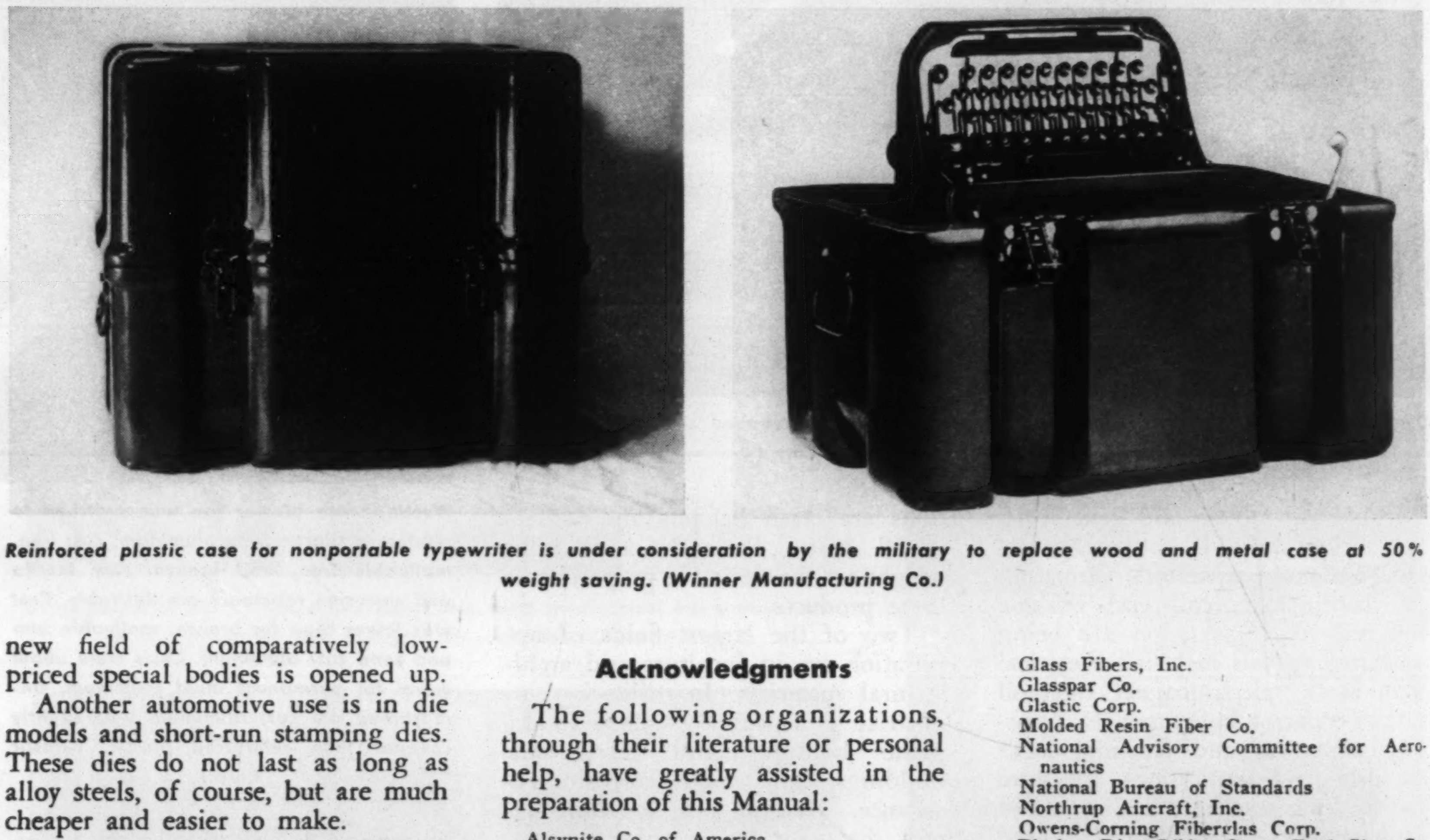
A recent, well publicized application is car bodies. Only custom-made, or special, low-production bodies are being considered. The material is strong enough to make a good body. Its big advantage is that relatively cheap molds are required for a given shape, so that custom bodies do not have to bear the cost of expensive dies required with metal. Thus, a



Aircraft ducting and inclosures of glass cloth-polyester are being used in increasing quantities. Weight advantage is gained over aluminum. (Flexfirm Products)



Strength, corrosion resistance and electromagnetic transparancy are all required in fronts for radio relays. (American Telephone & Telegraph Co.)



Reinforced plastic case for nonportable typewriter is under consideration by the military to replace wood and metal case at 50% weight saving. (Winner Manufacturing Co.)

new field of comparatively low-priced special bodies is opened up.

Another automotive use is in die models and short-run stamping dies. These dies do not last as long as alloy steels, of course, but are much cheaper and easier to make.

A number of other applications are in the tooling up stage or have just gone into production. Light weight bath tubs for house trailers, loud speaker horns, shower stall bases and liners for ice chests and frozen food containers are examples. Pressure containers for dispensing hot and cold beverages are in the same class. Another candidate is table top and panel material made by molding the material around Balsa cores.

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Materials Engineering File Facts

MATERIALS & METHODS
February • 1953
Number 244

Relationship Between Mechanical Properties and Hardness of Steels

The mechanical properties of a heat treated steel are largely determined by its structure. A steel having a pearlitic structure is soft, one having a martensitic structure is very hard, while steels having intermediate structures have hardness values lying between these limits. Reheating a steel having a martensitic structure results in the softening of the steel. By a suitable selection of the tempering temperature it is possible to obtain the same hardness in a fully quenched and tempered steel as in one in which pearlite or intermediate structures have been obtained directly. However, the yield strength and toughness are usually greater for a given hardness if the steel is processed through the martensitic step.

Numerous tests have shown that a definite relationship exists between the hardness and other mechanical properties of fully quenched and fully tempered carbon and alloy steels. The chemical composition can be varied widely and many combinations of carbon and alloying elements can be used to obtain the same properties, providing the steel can be hardened throughout to martensite. The relationship does not hold for steels which do not meet this requirement. By determining the hardness of fully quenched and fully tempered steels, it is possible to obtain a useful approximation of the yield point, tensile strength, elongation and reduction of area of such steels without performing a tensile test.

Steels vary greatly in their response to heat treatment. Practically all carbon steels and some low alloy steels are fully hardenable only to a very shallow depth in sections over 1 in. even by drastic quenching. Other low alloy steels are hardenable throughout in large sections. By determining the hardenability of a steel, it is possible to obtain an estimate of the maximum section which can be hardened throughout, a necessary requirement if the relationship between hardness and other properties is to be valid.

The following table shows this relationship. It is more accurate for steels containing 0.30% or more carbon than for lower carbon steels. Steels containing less than 0.30% carbon usually have yield points which are lower than those shown.

Rockwell "C" Hardness	Brinell Hard- ness	Tensile Strength, Psi	Yield Point, Psi	% Elong in 2 In.	% Red of Area
14	197	93,000–103,000	69,000–78,000	22–28	60–68
16	207	98,000–108,000	73,000–84,000	21.5–27.5	59–67
18	217	103,000–114,000	76,000–90,000	21–27.5	58–66
20	223	106,000–117,000	79,000–93,000	20.5–26.3	57.5–65.5
22	235	112,000–124,000	85,000–99,000	20–25.5	56.5–64.5
24	248	118,000–131,000	92,000–107,000	19.5–24.5	55–63
26	262	124,000–138,000	99,000–114,000	18.5–24	54–61.5
28	277	131,000–146,000	107,000–122,000	18–22.5	52–60
30	293	138,000–154,000	116,000–131,000	17–22	51–59
32	311	146,000–164,000	125,000–141,000	16–20.5	49–57
34	321	151,000–170,000	131,000–146,000	15.5–20	48–56
36	341	160,000–180,000	141,000–157,000	14.5–18.5	46–54
38	363	171,000–193,000	153,000–170,000	13.5–17	43.5–51.5
40	379	178,000–201,000	163,000–179,000	12.5–16	42–50
42	401	188,000–222,000	176,000–185,000	11–15	40–49

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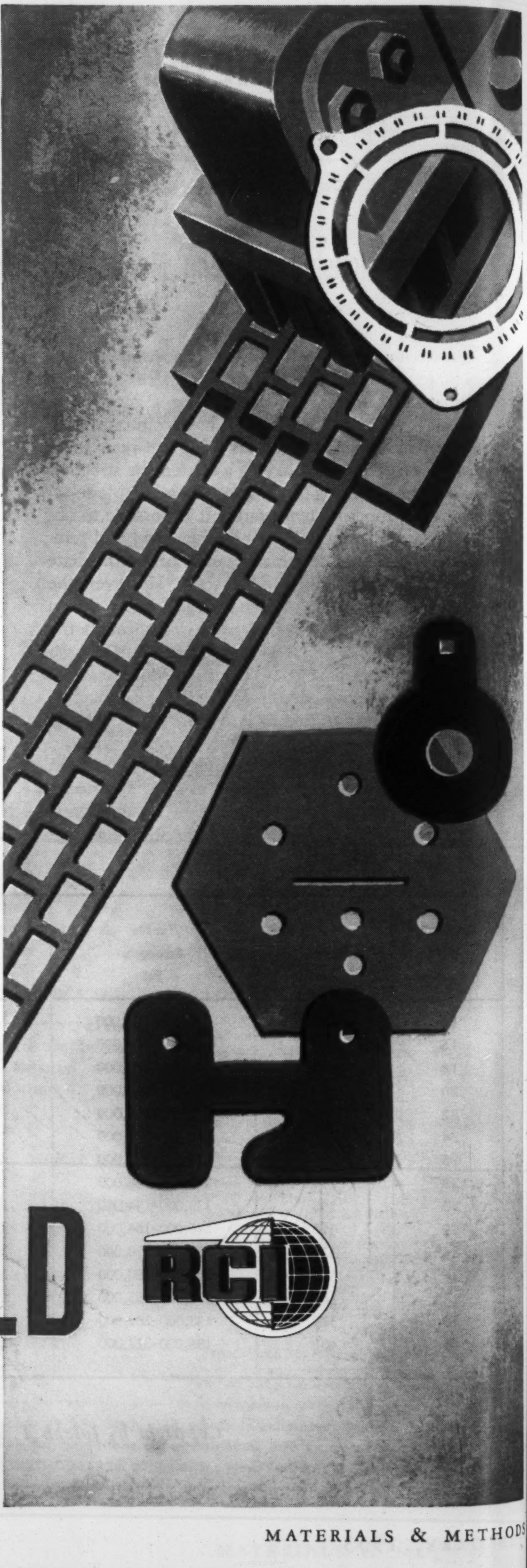

Materials Engineering File Facts

MATERIALS & METHODS
February • 1953
Number 245

Properties and Applications of Some Common Plastics

	Forms Supplied and Fabricating Methods	Typical Present Uses	General Properties and Performance Characteristics
		MOLDING MATERIALS	
Styrene	Molding powder for injection and extrusion molding for all types of machines and molds. Adaptable to machine blowing and compression molding. General purpose material, heat resistant, and improved impact strength are available.	An unusually wide range of applications, including: battery cases, refrigerator parts, equipment housing, radio cabinets, wall tile, fluorescent light fixtures, television parts, signs and displays, packaging, clocks, housewares, toys.	General purpose available in a complete range of transparent, translucent and opaque colors including natural crystal of exceptional clarity. Hard, rigid, with high dimensional stability. Excellent chemical and solvent resistance, tasteless, odorless and nontoxic. An excellent electrical insulator. General purpose satisfactory at temperatures up to approximately 180 F. Heat resistant material has higher heat resistance (up to about 200 F). Improved impact strength of general purpose styrene, and exceptionally good gloss for an impact material.
	Modified styrene plastic molding powder with markedly higher heat resistance for injection and extrusion molding.	For applications such as military items, surgical and hospital instruments, nursery articles and electrical appliances.	Good color range, exceptionally high heat resistance (up to 234 F) and good electrical properties, excellent dimensional stability, good mechanical properties and shock strength. Unaffected by weak acids and alkalies.
Phenolic	Supplied in molding compounds with various fillers. Particularly suitable for compression and transfer molding, and can be molded in automatic molding machines and other types of equipment.	For heavy-duty products such as washing machine agitators, equipment housing, junction blocks, pulleys, casters, handles for electrical tools and cooking utensils, camera cases, closures.	Excellent resistance to alcohol, oils, greases, petroleum derivatives, other solvents and weak acids. Tasteless and odorless, making it particularly adaptable for closures. Outstanding heat resistance combined with surface hardness. High-impact strength compounds available for heavy impact applications. Electrical grade compounds have superior dielectric strength, low dielectric constant and power factor. Special closure compounds have high torque strength.
Melamine	Supplied as thermosetting molding compound for compression and transfer molding made from melamine resin with mineral fillers and cellulose fillers.	Particularly suited to applications requiring good arc and track resistance, such as all kinds of electrical, electronic and radar equipment: circuit breaker parts, terminal blocks, connectors, insulating tubes.	Strength properties comparable to phenolics. Excellent resistance to alkalies, oils, greases, petroleum derivatives, alcohol, organic solvents and weak acids. Remarkable surface hardness, durability, weathering and aging. Good moldability around inserts with fast cure and outstanding mold release.
		FABRICATING MATERIALS	
Vinyl Chloride	Supplied as film and flexible sheeting in rolls, in a variety of uniform gages. Can be printed, embossed or molded. Also available in several embossed patterns. Special heavy gage formulations available with good flexibility at low temperatures. Inlaid vinyl sheeting, with an inlaid pearl pattern, supplied in flexible sheets 23 by 54 in.	Typical applications for the film are draperies, shower curtains, tablecloths, closet accessories, aprons and rainwear. Low temperature flexible used for heavy duty rainwear and protective storage coverings for machinery and heavy equipment. Inlaid serves as upholstery for dinette chairs, hampers and small pieces of furniture.	Color clarity and uniform gage are outstanding qualities of film. Wide color range available in transparent, translucent and opaque colors. Has good tear strength and is not affected by moisture, mildew, or weak acids and alkalies. Tasteless, odorless, and nontoxic. Low temperature flexible is extremely tough and has excellent flexibility at low temperatures. Inlaid sheeting has good dimensional stability, works easily, can be tacked or cemented, and has a beautiful pattern that will not wear off.
Cellulose Nitrate	Supplied in sheets 20 by 50 in. in varying thicknesses. Adaptable to heat forming, blow molding, stamping, machining, drawing, and other standard fabricating methods. Extremely wide range of beautiful patterns.	Typical applications include: eyeglass frames, toilet seats, hamper tops, piano keys, drawing instruments and cutlery handles.	Exceptional toughness and beauty and variety of pattern possibilities are outstanding characteristics of Nitron available in no other plastic. Good mechanical properties, resilient but not elastic. Attacked by some organic solvents but resistant to weak alkalies and weak acids.
Cellulose Acetate	Supplied in sheets 20 by 50 in. from 0.005 to 0.250 in. in thickness, and in continuous rigid film both clear and colored in widths up to 60 in. Adaptable to heat forming, blow molding, stamping, drawing, machining, and other standard tool methods. Continuous material on rolls allows more economical cutting, and is adaptable to continuous fabricating methods such as beading, plating and roll printing.	Glare screens, goggles, sunglass frames, toys and novelties are typical applications stamped from sheets. Continuous in pastel colors forms beautiful lamp shades.	Supplied in a wide range of colors including transparents and clear crystal. Good toughness and excellent mechanical properties. Resilient but not elastic.

(*Continued on page 141*)

How to get an all-star casting

Are failures of cast parts costing you time and money? Production stoppages—machinery breakdowns—frequent repairs and parts replacement?

Then you may find an INCO Nickel or Nickel Alloy casting the ideal solution to your difficulties.

You can depend on Nickel and Nickel Alloy sand, centrifugal and precision castings wherever rough treatment and rugged operating conditions prevail. As these five examples show, they are strong. They maintain product purity. They resist erosion, corrosion and abrasion.

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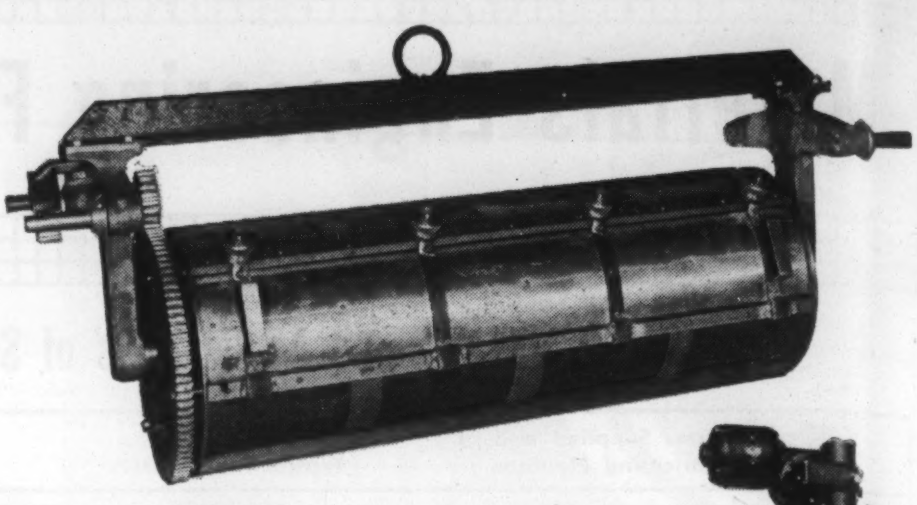
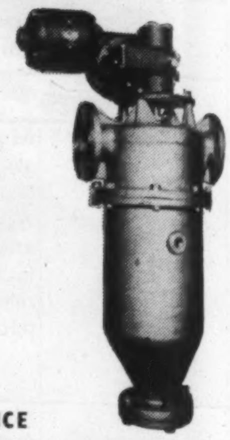


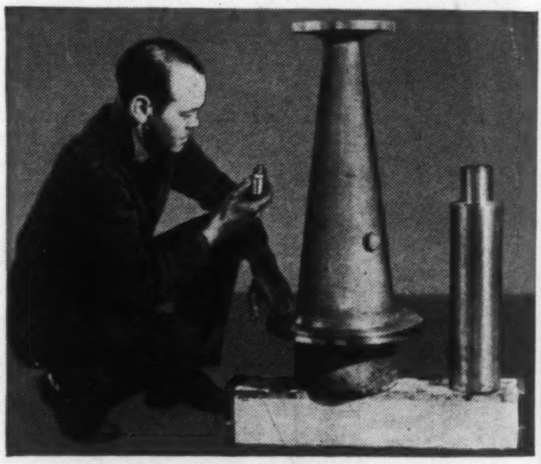
STRENGTH

The gear-end idler, idle-end hanger, ring gear and pinion of this Monel® tumble-pickling barrel must support the heavy load . . . stand up under the torturous grinding of the gears . . . the constant jouncing of the barrel . . . resist the corrosive action of acid and alkaline solutions. That's why they're made of cast Monel



PURITY MAINTENANCE

This cast Monel filter is guarding product purity in the manufacture of a well-known pharmaceutical product. Monel's high resistance to corrosion makes it invaluable wherever industry needs freedom from harmful metal contamination.

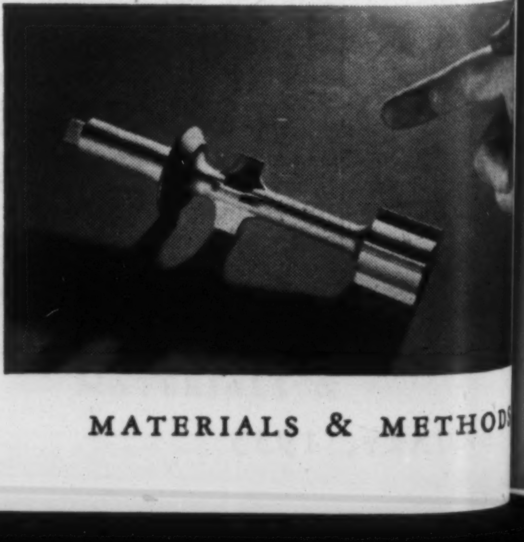


EROSION RESISTANCE

Withstanding high pressure steam blast at three times the speed of sound and 800°F, these cast Monel nozzles are still in excellent operating condition after 30 years of service. Records like this show the longer equipment life and excellent performance that can be expected from Monel castings.

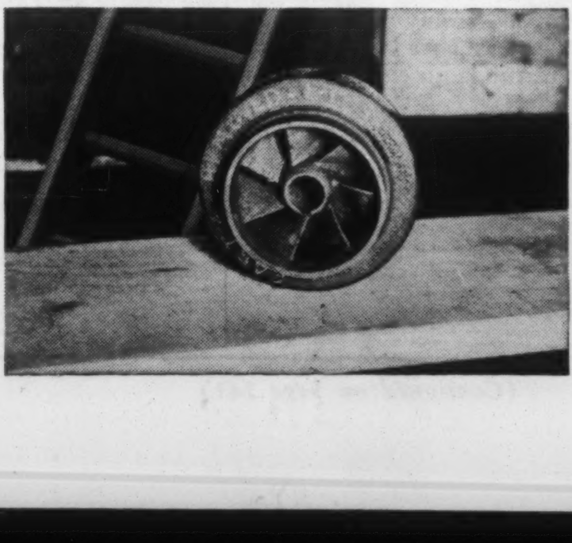
CORROSION RESISTANCE

Chlorine would chew up tank car valve parts unless they were highly corrosion resistant. That's why the Chlorine Institute recommends the use of Monel for parts like this investment cast valve stem. If your problem is corrosion, it is more than likely that you can find a practical way to solve it economically with INCO castings.



ABRASION RESISTANCE

This "S"® Monel sand-cast impeller gave 367% longer service than previously used metals despite the abrasive action of "coke breeze." Spinning at 1750 rpm in a gas company's quenching operation, this "S" Monel impeller served without trouble for 22 months, more than 3 times as long as some other metals. Such hardness and toughness of "S" Monel castings cut repair and replacements costs . . . save time, trouble and money.



Materials Engineering File Facts

MATERIALS & METHODS
February • 1953
Number 245

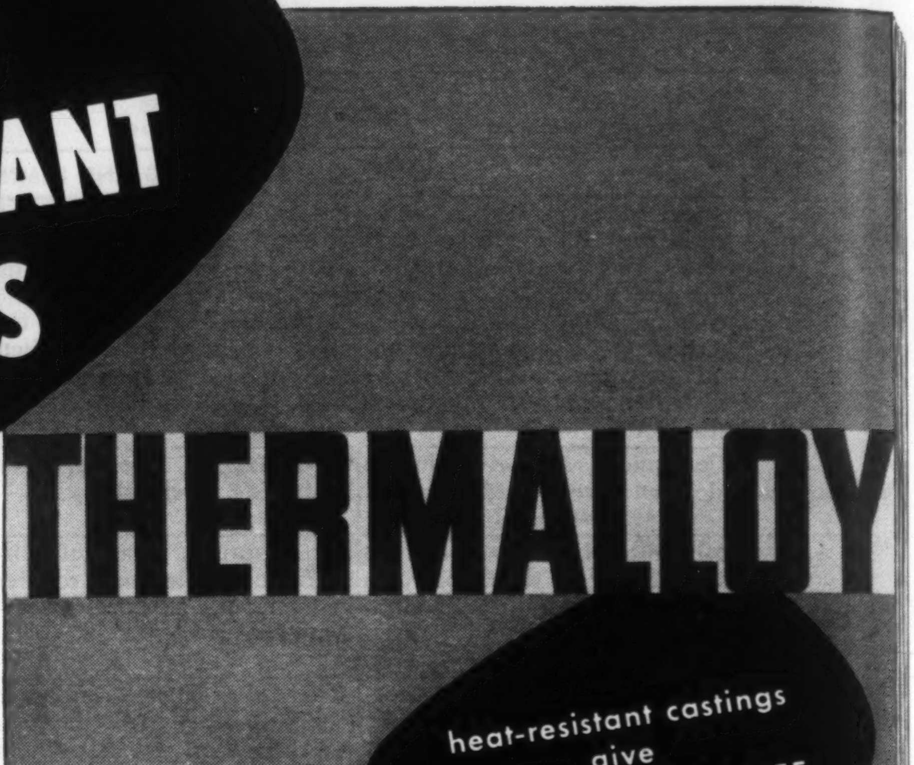
Number 245 (continued)

PROPERTIES AND APPLICATIONS OF SOME COMMON PLASTICS

	Forms Supplied and Fabricating Methods	Typical Present Uses	General Properties and Performance Characteristics
		EXTRUDING, CALENDERING AND LAMINATING MATERIALS	
Vinyl Chloride	Supplied as a dry powdered resin and in the form of a series of special compounds for profile extrusion and wire coating. Also used in the injection molding of the elastomeric items. Particularly suited to dry blending operation.	Calendered into film and sheeting for upholstery, draperies, shower curtains, rainwear, protective covers and packaging. Extruded in the form of garden hose, gaskets and all types of profile extrusions, and widely used for wire coatings.	Vinyl chloride is compounded with plasticizers and fillers to bring out the properties best suited for particular products. For curtains and draperies. Provides exceptional color uniformity. For garden hose, good resistance to weathering, aging and wear are properties furnished by the material. For rainwear, good flexibility at low temperatures combined with toughness and strength are outstanding characteristics.
Vinyl Butyral	Continuous adhesive film in clear and green-shaded form.	Used as the interlayer for laminating safety glass.	Tough and resilient, high adhesion to glass, clear transparency and freedom from haze. Green-shaded material produced in graduated tones to reduce sun glare.
Melamine	Melamine resins supplied as soluble spray dried powders for laminating paper, cloth and fibers.	For beautiful, practical surfaces for table and counter tops, and for all kinds of furniture.	Produces a tough, durable surface with pleasing decorative values. Melamine laminated surfaces will not stain or discolor; resist scratching and chipping; clean easily with a damp cloth; have outstanding resistance to chemicals; can be made in special heat resistant grades.
Phenolic	Supplied as solutions in alcohol or other organic solvents, or water. Applied as laminating, bonding and impregnating resins for paper, fibers and abrasive grains.	Electrical and mechanical grade laminates made with phenolic used for coil forms, switch bases and plates, gears, safety helmets, and for laminating the core stock of melamine decorative laminates.	Phenolic laminates are cured by the application of heat to form a hard, rigid bond with the material to which applied. The cured laminate is highly resistant to solvents, water, weak acids and alkalies. Heat resistance is high, usually not lower than 300 F.
		INDUSTRIAL AND COATING RESINS, AND ADHESIVES	
Phenolic	Special phenolic resins in liquid form or dry powder are supplied for foundry applications.	Used as the bonding agent to form sand into molds for shell molding and as core binders for metal casting. Monsanto also supplies urea resins for core binders.	Shell molding resins, for special mold making cycles and various cast metals, permits high production rates of close tolerance and castings of superior finish. Core binder resins designed to increase foundry core making capacity by as much as 50% and permit superior castings.
	Supplied as dry powders. ground lump or liquid resins for bonding, impregnating or treating other materials.	Used as impregnants or bonding materials for grinding wheels, clutch facings, brake linings, filter elements, rock and glass wool insulation, gaskets, etc.	Good heat and chemical resistance, with electrical insulating qualities as well. High strength depending upon the materials with which they are combined. Must be cured with heat and usually, but not always, some pressure.
	Phenolic resins in liquid solution form for formulating industrial baking finishes.	Formulated primarily for use in food can, drum and tank car linings.	Excellent chemical and solvent resistance, relatively free of taste and odor.
Melamine and Urea	Resins in liquid solution form for baked enamel and industrial finishes.	Used to improve protective finishes for appliances, automobiles, furniture, outdoor signs and equipment.	Melamine and urea resins have special functions in the formulation of baking finishes. Impart improved soap resistance, increased surface hardness, faster cure, improved chalk resistance, and better gloss.
Styrene	Plasticized or unplasticized powders or lattices.	In water-base paints, as the main vehicle for the paint and as a protective colloid. As a treating resin in industrial applications such as battery separators.	Styrene lattices form the basis of a new post-plasticized styrene system for water-base paints. Alkali soluble resin serves as a stabilizer, film hardener and adhesion promoter in many water emulsion systems.
Vinyl Butyrate	Supplied as resin solution and dispersions, and as a dry powder.	For coating cloth and paper, as an adhesive, as a metal conditioner, and as a component of baked coatings.	Tough and resilient, high adhesion and good transparency.
Urea, Phenolic, Melamine and Resorcinol Resins	Available as dry powders and liquids for hot and cold pressing, and radio frequency equipment.	Applied as bonding, cold setting and impregnating adhesives and glues for plywood, furniture, aircraft. Also used for molding granulated wood.	Various properties are available for requirements demanding water resistance, weather resistance, waterproof gluing, heat resistance, high strength and quick-setting.
Casein and Soybean Adhesives	Bonding and cold setting glues for hot-press, cold-press, low pressure bonding and secondary gluing.	Used for plywood, furniture, cabinet-making and in nail gluing for prefabricated housing.	Suitable for applications where temperatures are as low as freezing. Adhesives give strong glue bonding with low to high water resistance.

Courtesy Monsanto Chemical Co.

here's help in ordering HEAT-RESISTANT CASTINGS


THERMALLOY
heat-resistant castings give LONGER SERVICE LIFE
AMERICAN Brake Shoe COMPANY
ELECTRO-ALLOYS DIVISION · ELYRIA, OHIO

NEW BOOKLET gives complete information about THERMALLOY*

Ordering the *right* heat-resistant castings that give you top performance with the longest service life . . . requires a careful analysis of your problem. At Electro-Alloys, you will find the trained personnel and facilities needed for this service.

This new, 16-page, illustrated booklet will give you the complete story . . . with photographs of modern foundry facilities . . . case histories of Electro-Alloys design and engineering help . . . suggested Thermalloy applications for your industry . . . technical charts that give you detailed performance figures for the various grades of Thermalloy.

For your answers to how Electro-Alloys can help you with Thermalloy heat-resistant castings, write for your free copy today . . . Electro-Alloys Division, 4001 Taylor Street, Elyria, Ohio.

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AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION
ELYRIA, OHIO

New Materials and Equipment

Transparent Plastic Pipe Has Many Uses

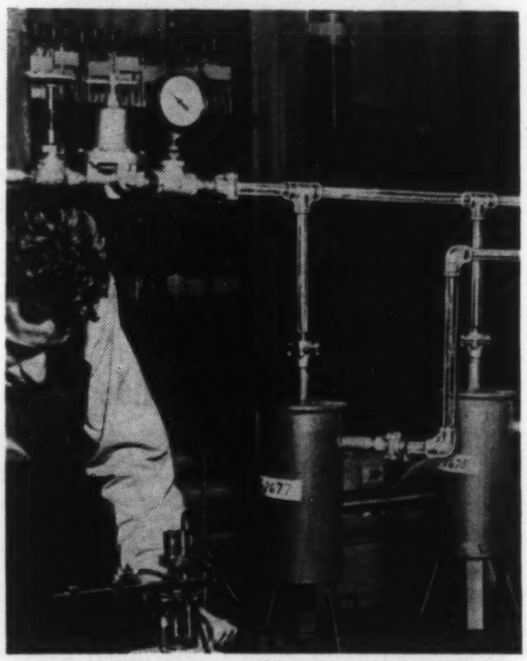
Transparent plastic pipe and fittings of cellulose acetate butyrate in sizes ranging from ½ through 4 in. are now available for laboratory and pilot plant use from *Elmer E. Mills Corp.*, 2930 N. Ashland Ave., Chicago 13. Known as Mills III, the new pipe offers many advantages for handling oils, gases, water, slurries and a wide variety of chemicals because it permits observation of processes, and has extremely high resistance to corrosion and other forms of chemical attack.

Sections of the pipe are quickly and easily joined by a solvent cement that produces a leak-proof, homogeneous bond. No threading or special tools are required, even when connecting to standard steel pipe and fittings. Set-ups can be dismantled and all components used over again, and alterations in any set-up can be made in minutes.

A complete assortment of Milex plastic fittings is available for use with Mills III pipe, including flange unions and flange adapter unions for joining plastic to steel or plastic to plastic, as well as the usual ells, tees and couplings. Two flange adapters and a length of the pipe make up a clear and reliable sight glass. Other uses include vent lines, drain lines, compressed air lines, etc.

Mills III is tough, shatterproof, and requires a minimum of support. Although semi-rigid, it is flexible enough to permit broad radius bends and considerable misalignment. Sizes up to 2 in. have a working pressure of 100-lb psi at 100 F.

According to the company, there are almost no limits to the laboratory uses of the pipe. It is reasonable in cost, the smaller sizes actually costing less than a good grade of laboratory tubing. Black pipe made of the same material is also available.



This plastic pipe finds wide application in laboratories because of its resistance to corrosion and chemical attack.

Low Cost Melamine Laminate Has Improved Properties

A new, low-cost glass mat melamine laminate is currently being produced by *Synthane Corp.*, Oaks, Pa. The new grade, which is said to combine high fire and arc resistance with good mechanical and chemical properties, will soon become standard for all Navy electrical power and lighting applications.

Designated by the company as G-8, the laminate is available to suppliers of electrical and power equipment at a considerable saving under the cost of the continuous filament glass-base material (NEMA Grade G-5) whose electrical properties it is claimed to match.

The new material, laminated in thicknesses from 1/16 in. upward, uses a glass fiber mat impregnated with melamine resins. Thus, its mechanical properties are less directional than those of a woven base laminate. Lower production costs of the material are due to the elimination of weaving operations. Also, no lubricant need be applied and removed later, as in the case of woven fibers.

In addition to electrical applications, the laminate is expected to be particularly useful where chemical resistance is required, such as in the plating and photographic industries.

The following engineering information lists pertinent data on the new G-8 grade:

Size: 36- by 36-in. sheets, 1/16-in. thickness upwards.

Flexural strength, flat-wise; ½-in. thick sample:
    Lengthwise direction, 24,000 psi.
    Crosswise direction, 20,000 psi.
Impact Strength, edgewise, ½-in. thick sample:
    Lengthwise direction, 6.0 ft-lb.
    Crosswise direction, 6.0 in notch.
Water absorption, 24 hr:
    1/16-in. thickness, 2.70%
    ⅛-in. thickness, 2.00%
    ½-in. thickness, 1.50%
Dielectric breakdown; ⅛-in. thick sample:
    Parallel to laminations. . .65.0 Kv
    Perpendicular to laminations . . . 200.0 v per mil
Bond Strength, 1200 lb.
Arc Resistance, 185 sec.

Flaws are more quickly evaluated when viewed through the precision ground triple power glass shown here.

Black Lights for Fluorescent Penetrant Inspection

Burton Manufacturing Co., 11201 W. Pico Blvd., Los Angeles 64, Calif., has announced a new Burton Magnifier Black Light which complies with Air Force Specification MIL-I-6866 covering black lights used for fluorescent penetrant inspection on metals, ceramics, castings, parts, etc.

The new unit, No. 1931, is said to reduce operator fatigue and increase perception of defects. Flaws are more quickly evaluated when viewed through the precision ground triple power glass. This oblong lens is scientifically mounted in the smooth bakelite head. Weight of the entire unit is only 30 oz. It measures 7 by 5 by 2 in.

Twin tubes produce prolific but harmless 3660A ultra violet energy which is directed upon the inspected surface. There is no back glare or heat to affect the operator's perceptions. Long life tubes have low replacement cost, instant start or stop type.

When desired, white fluorescent tubes can be used in the unit for high detail inspections. Both hand held and stand models are available.

Improvements in Black Oxide Finish Announced

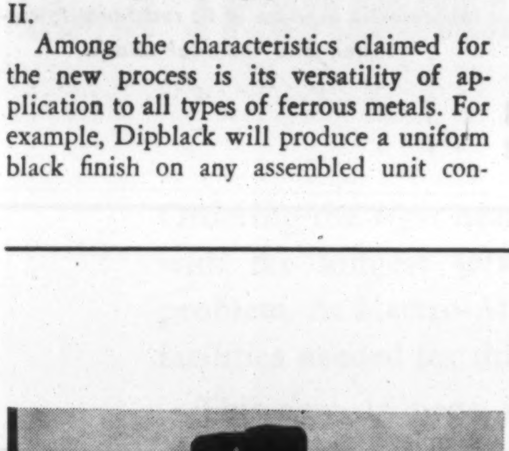
Special Chemicals Corp., 30 Irving Pl., New York 3, has announced new, improved features in their Dipblack process which are said to result in faster production, greater economy and uniformity on all types of ferrous metals. Dipblack is an immersion black oxide finish developed during the early part of World War II.

Among the characteristics claimed for the new process is its versatility of application to all types of ferrous metals. For example, Dipblack will produce a uniform black finish on any assembled unit consisting of different types of iron and steel (mild carbon and spring steel). No change in processing is said to be necessary due to the product's compatibility with all types of iron and steel. One bath does the job.

Simple control of the Dipblack solution is afforded by Dipblack Colortrol and Dipblack Anti-spray. These marked improvements make the solution practically self-controlling. The Colortrol, a specially prepared replenishing salt, maintains the solution in proper balance, insuring against off-color deposits, and assures a lustrous uniform fine black finish on all ferrous products. The Anti-spray, an exclusive inhibition agent, protects workers and keeps solution from running down outside of the tank.

The finish does not affect dimensions or surface texture because it becomes an integral part of the metal itself. It will not chip, peel or scale during or after welding, soldering, bending, punching, stamping or rolling. Alkali, solvents or high temperature cannot in any way harm the metals that are treated by this process.

New 90-Degree Spectrometer for X-Ray Analysis



This analysis tool finds many uses in research, educational fields, and in production control.

A new Norelco 90-deg Geiger-counter x-ray spectrometer that is said to provide at minimum cost a powerful analysis tool for use in research and educational fields as well as for production control, is now available from the Research and Control Instruments Div., *North American Philips Co., Inc.*, 750 S. Fulton Ave., Mt. Vernon, N. Y.

Designed to provide a full standard range of operation, the new instrument employs a long-life, air-cooled x-ray tube and a goniometer having a radius of 130 millimeters. Angular range is −10 to +90 deg (two theta). Angles can be read directly from a dial or from a strip chart (degree optional). The angle can be varied quickly by a manual drive or by employing the incorporated motor drive. The Geiger-counter position is continuously readable to 0.01 deg (two theta) over the full range.

The high output x-ray generator provides fixed operation at 35 KvP at 6 Ma and operates on 200 to 240 v, 50 or 60 cycles. X-ray generator is self-rectified for simplicity and low tube replacement cost. X-ray tube is air-cooled and can be quickly interchanged. Voltage and current stabilizers are included.

The new unit is designed specifically for spectrometric work and the goniometer reads directly in degrees, with a separate dial reading in hundredths. It is easily aligned with gages and fixtures provided as part of the equipment.

Lubricating Enamels Can Be Brushed or Sprayed on Any Surface

Tough, adherent, load-bearing dry-lubricant finishes can now be applied to any machine or instrument surface using ordinary brush or spray techniques and without special equipment, according to a recent announcement from the Lubricants Div., *The Lockrey Co.,* Southhampton, N. Y. All this is said to be made possible through the use of new types of Liqui-Moly molybdenum-base lubricating enamels now offered by the company on an experimental basis.

The new lubricant coating, Molynamel, puts a lustrous, hard, greasy-feeling but clean coating, from a fifth to half a thousandth thick, on any type of surface, over practically any kind of material (plastics, glass, ceramics), according to company reports. It is said to be especially effective on porous surfaces, since it fills the pores and provides a feeding-supply of lubricant. The excellence of finish on bearing-parts becomes of less importance, since the Molynamel surface, and not the machined surface, carries the load and governs friction. Except in extreme cases, normal clearances need not be disturbed, since the final coating-thickness is no greater than the normal allowances for oil alone.

The coating might also be of interest in printed circuit techniques, since it can be silk-screened or otherwise applied in irregular patterns. Probably its most effective use will be in instruments, optical and electronic apparatus where liquids or materials containing volatiles cannot be employed due to possibilities of freezing, contamination or clouding of optics, or where dry powders cannot be used due to difficulties of application and lack of adhesion or loose particles.

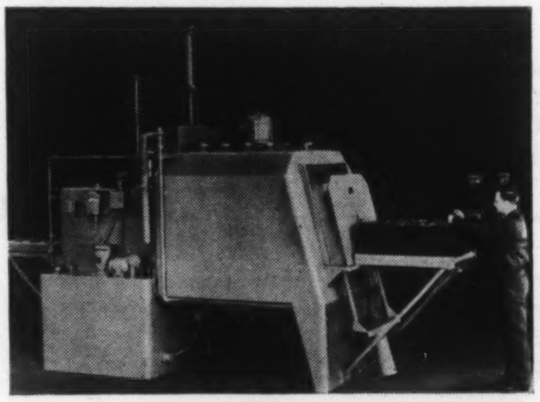
Heat Treating Unit Features 100% Forced Convection Heating

A new 400 lb per hr automatic heat treating unit, featuring 100% forced convection heating, has been announced by *Ipsen Industries, Inc.,* 715 S. Main St., Rockford, Ill. The new unit operates at temperatures up to 1850 F, and has complete automatic straight-through operation from heat through cooling or oil quench. The unit is sealed to provide absolute atmosphere control during the entire heating and quench cycle, assuring bright, scale-free work on all types of heat treating processes such as carburizing, carbonitriding, etc.

The Ipsen 100% forced convection system employs the use of the non-alloy radiant heating tubes, baffles, and a powerful fan mounted in the roof of the furnace. The tubes are spring loaded and positively sealed by means of compression bellows and are designed for either gas-fired or electric heating elements. The heating tubes are mounted vertically between the brick insulation and an interior demountable baffle. A powerful alloy fan forces the endothermic atmosphere around the baffles, past the radiant tubes, and then up through the floor and the work.

Like other company units, the T-400 straight-through design saves handling time and loading delays. Work is loaded directly into the heating zone, and after proper time at heat, the work tray is automatically transferred onto a quench-cool rack which holds load for atmosphere cooling, or lowers it for oil quench, whichever has been pre-selected on the cycle control panel. As soon as the tray is on the rack, a new load can be put into the heating zone immediately.

The versatile unit is used to normalize, stress relieve, harden, carburize, carbonitride, and braze, and can be supplied with a special insulated tank for martempering or hot oil quenching.



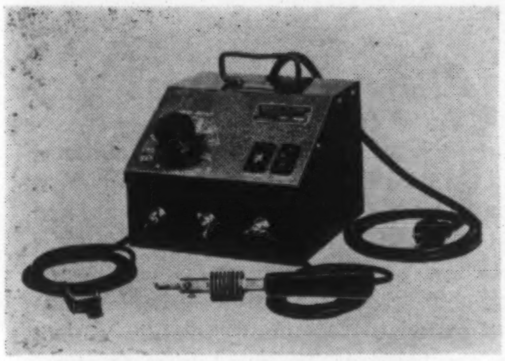
This 400-lb per hr automatic heat treating unit operates at temperatures up to 1850 F.

Rubber-Like Coating Meets Army Ordnance Specifications

Cycloflex No. 7731, a specially formulated plastisol to meet Army Ordnance Specifications, has been announced by *Munray Products, Inc.,* 12400 Crossburn Ave., Cleveland 11. The product is in the form of a free-flowing, viscous liquid, which, with heat, is converted into a flexible rubber-like coating. When applied to component metal parts, a smooth, dense, tough, highly abrasion resistant, resilient, rubber-like coating is said to be obtained. Coating can be furnished from 1/32- to ½-in. thick and is said to replace rubber or rubber bonded coatings.

The new coating is claimed to have excellent chemical resistance to oils, greases, acids, alkalies, salts of inorganic acids as well as petroleum solvents. Coatings are resistant to oxidation, will not harden, check or craze on aging. Cycloflex Spec. No. 7731 has been approved by the Army Ordnance Fire Control Div. It meets both the –45 F and fungus resistance requirements plus other required specifications.

Soldering Unit Offers Improvements



This soldering unit produces instantaneous heat, thus simplifying any type of soft soldering.

The Wasserlein Manufacturing Co., Inc., 126 W. Cass St., Joliet, Ill., has announced recent design modifications made on its Glo-Melt soldering unit. The unit, utilizing the resistance or conduction principle, produces instantaneous heat that simplifies any type of soft soldering. External changes and a new grey hammerloid finish give the Model 105-B1 Wassco Glo-Melt power unit an attractive appearance.

For added safety in operation, a red jewel-type pilot light has been added to provide the operator with a constant visual reminder of when the power supply is being used. A new type on-off switch is another feature that has also been incorporated into the design.

The function of the power unit is to supply and regulate the amount of electrical current required to reach the proper soldering temperature for metals of different degrees of electrical resistance and for joints of various sizes. A selector knob indicating 24 separate degrees of heat on its dial gives the power unit a rating of 450 watts at maximum heat and 80 watts at low heat; it is rated for 25 watts on standby. The power unit plugs into 115-v, 60-cycle outlets.

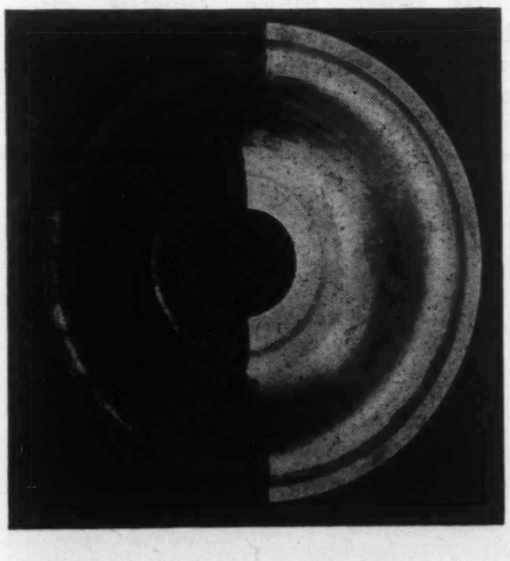
New Polyvinyl Chloride Competes With Rubber

A new and patented compounded polyvinyl chloride developed by the *Calresin Corp.,* 333 N. Santa Anita, Arcadia, Calif., is currently being offered for unusual packaging requirements.

Designated CPC, the compound under various weights does not compress the same as air foam products. However, it compresses considerably more than many types of rubber now on the market. This feature results in a cushioning or floating of the article being packaged. Simultaneously, Calresin CPC meets many requirements and specifications which cannot be accomplished through any known rubber compounding, including extreme cold temperatures. Among other outstanding features claimed are: it can be formed or molded inexpensively in any shape to fit the article it is to protect; it can be molded with a covering of cloth or other material on either side; it can be bonded to any known surface; it is fungus proof and will not support combustion. Various grades in all colors are supplied and engineered specifically to the article to be protected.

Examples of the compound's weight adaption characteristics are shown in the extreme cases of one Navy product presently being cushioned with it weighing only 3 oz while another product weighs more than 60 lb. Units considerably heavier can be cushioned with this material without causing any excessive cold flow.

Acid Derusting and Descaling Compound Announced



The right half of this part has been treated with the new derusting and descaling compound.

Enthone, Inc., Dept. MM, 442 Elm St., New Haven, Conn., has announced a new compound, Enthone Descaler 2A, for rapid removal of oxide and scale from steel. The product is acidic in nature and is available in dry powder form. It is used in concentrations ranging from one to several pounds per gallon, with temperatures ranging from 70 to 180 F, depending upon the speed of descaling that is desired and the type of scale.

According to the company, the compound permits controlled acidity to be obtained which permits uniform pickling with a minimum of attack on the base metal. The surface is left cleaner and brighter than when acids are used.

The product contains surfactants to dislodge oil films, to promote faster pickling, and to give white clean surfaces after descaling or derusting. The manufacturer states that the product is ideal for tumble or barrel derusting or descaling. It is also used for removal of rust or scale in vats or tanks, for primary pickling, or for plating cycles. A layer of foam forms on the pickling solution which practically eliminates fumes, thus making the pickling or descaling operation more pleasant to the operator and reduces corrosion on surrounding equipment.

Descaler 2A, because it is a free flowing powder, presents less hazards in handling than those present with the handling of acids, such as hydrochloric or sulfuric acid. The product is available in 100- and 400-lb containers.

(More News on page 148)

a proven steel

FOR GAS TURBINE STRUCTURES

N-A-X

AC9115 ALLOY STEEL

The production of gas turbines for jet aircraft engines and other uses is dependent upon metals which at both high and low temperatures have good strength, toughness, and stability before and after welding. N-A-X AC9115 ALLOY STEEL possesses these properties and is applicable to those parts where the operating temperatures range from −70° F. up to about +1000° F., and where suitable coatings are used for surface protection against normal and hot corrosion.

N-A-X AC9115 ALLOY STEEL has outstanding cold forming and welding characteristics and conserves critical alloys in its composition.

For more information about N-A-X AC9115 ALLOY STEEL, send for our new booklet.

A New Booklet
For Design Engineers

N-A-X
for gas turbine structures

Write for this 16-page booklet on N-A-X AC9115 ALLOY STEEL. It describes the properties and characteristics of this material and offers information on its fabricating and welding properties.

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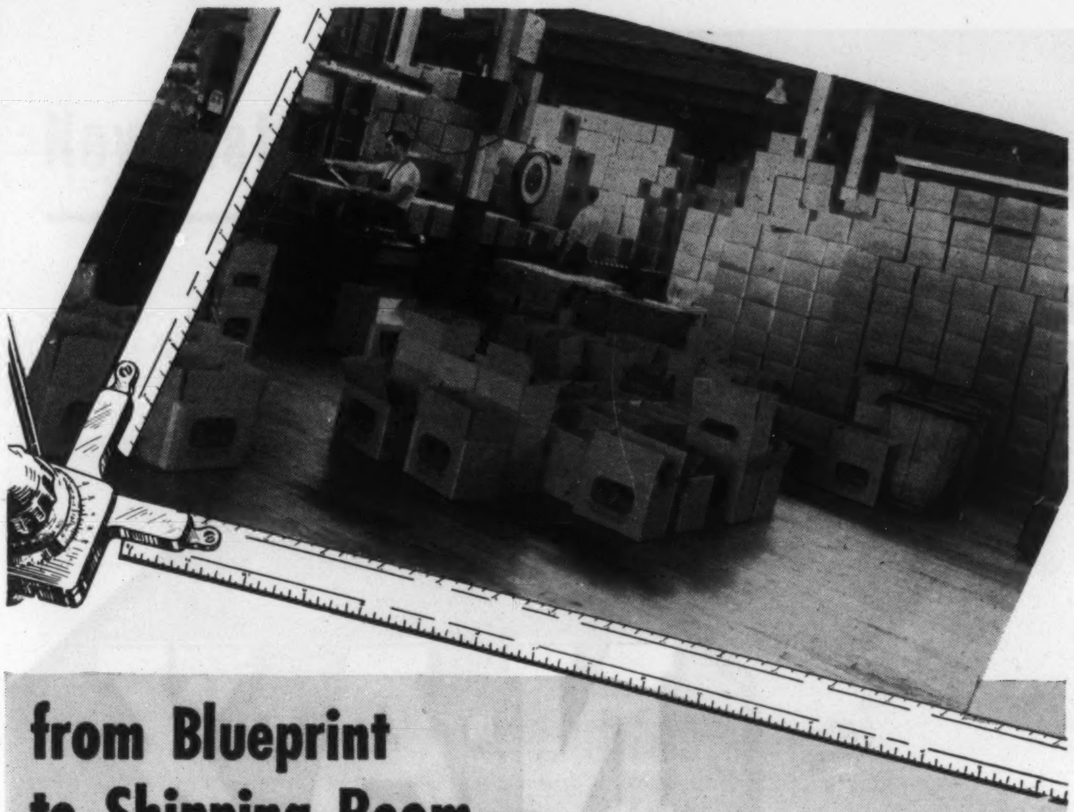
NATIONAL STEEL CORPORATION

Makers of the famous N-A-X HIGH-TENSILE STEEL



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ACUSHNET Molded Rubber Parts are *Engineered* for Dependable Performance!

Every operation in the production of ACUSHNET precision-molded rubber parts is directly controlled by our Engineering Staff. An uncompromising Quality Control System requires rigid laboratory tests and certified approval at each stage of production before the job can be released for the next operation.

As a result, ACUSHNET parts are known throughout industry for their efficient, trouble-free performance in the countless assemblies of which they become integral members.

When your molded rubber parts require engineered precision — specify ACUSHNET.

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Send for your copy of the widely used "Acushnet Rubber Handbook", a comprehensive, practical rubber data reference.

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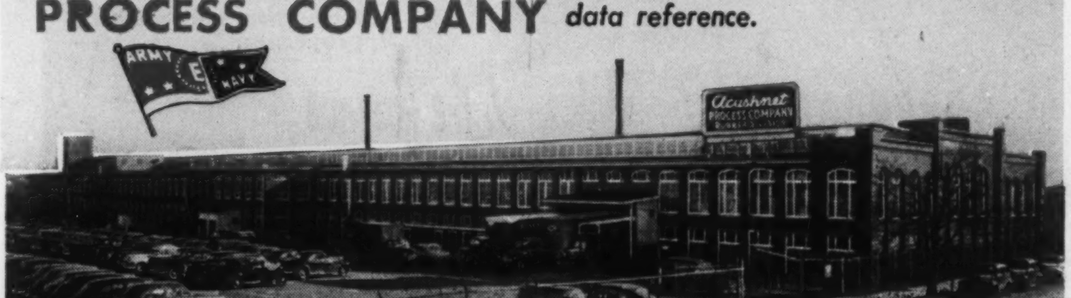
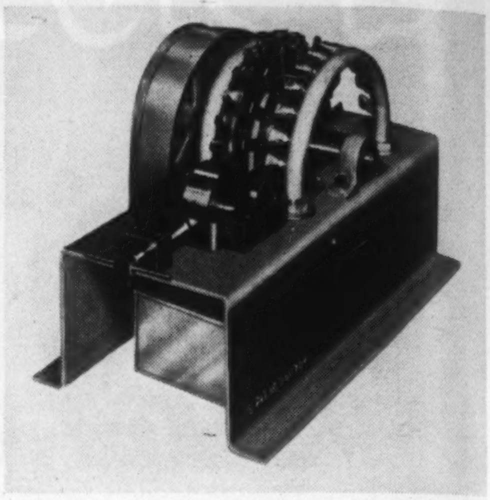


New Materials and Equipment



Testing Unit Determines Steels' Resistance to Heat Checking

Thermo-Test, a new tool developed for determining the relative resistance of different materials to heat checking, is currently being offered by *Henry G. Keshian*, Hotchkiss Grove, Branford, Conn.

Test pieces are successively heated, stressed and cooled. This cycle of heating, stressing and cooling is repeated until the specimen develops visible cracks or heat checks. The number of cycles to produce heat checks are indicated on a counter attached to the machine. As many as 18 test pieces can be tested at one time.

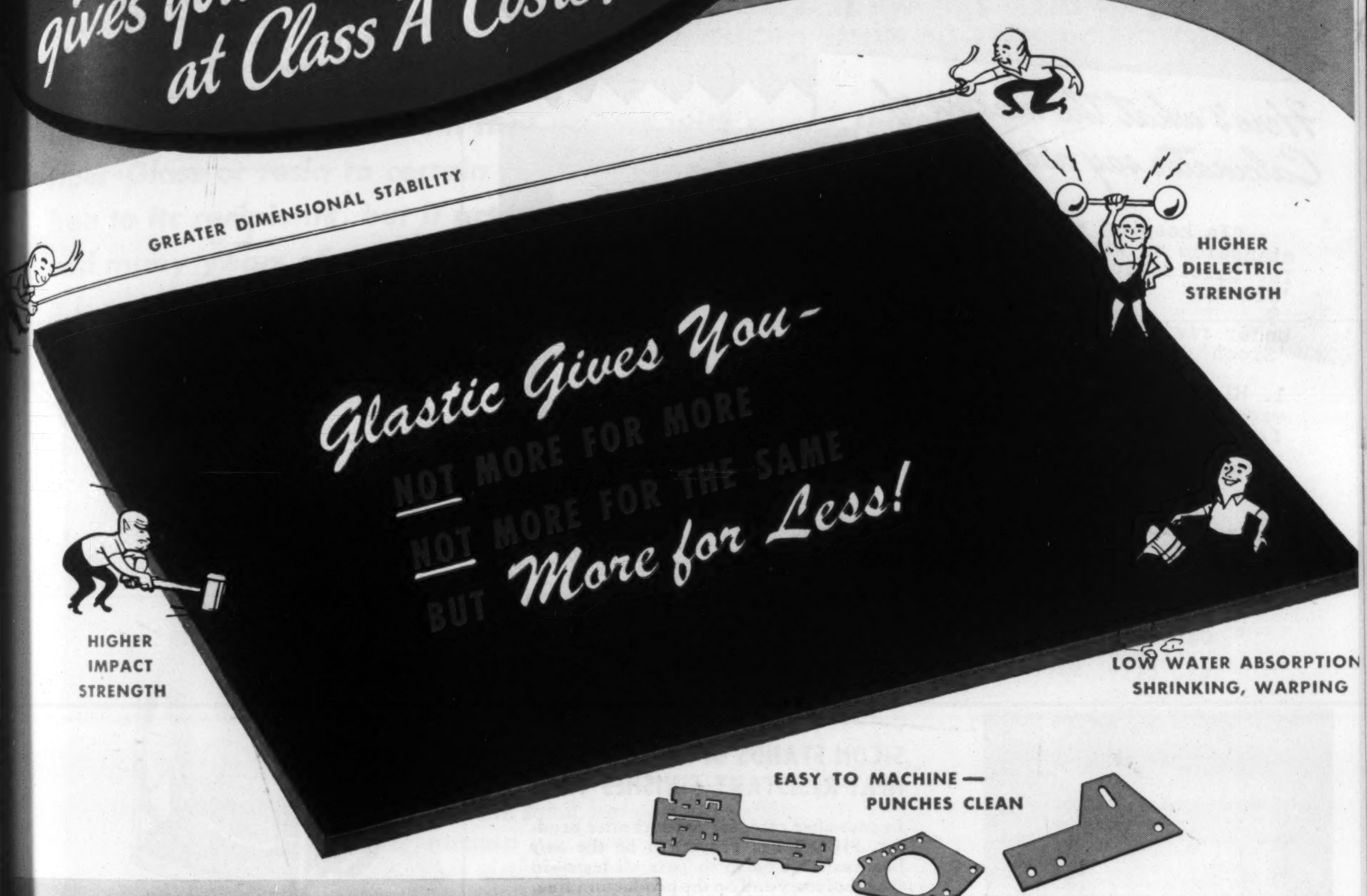
The effects of various heat treatments, the range of heating and cooling, amount of pressure applied to the specimen, and the effects of various alloying elements on the resistance of steel to heat checking can be studied. Various materials used for molds, permanent molds, die casting dies, glass molding dies, drop forging dies, hot piercing mandrels, extrusion dies, hot rolls, etc., can be tested. The unit measures approximately 24 by 36 by 18 in.

Thin 75S Aluminum Clad Now Available

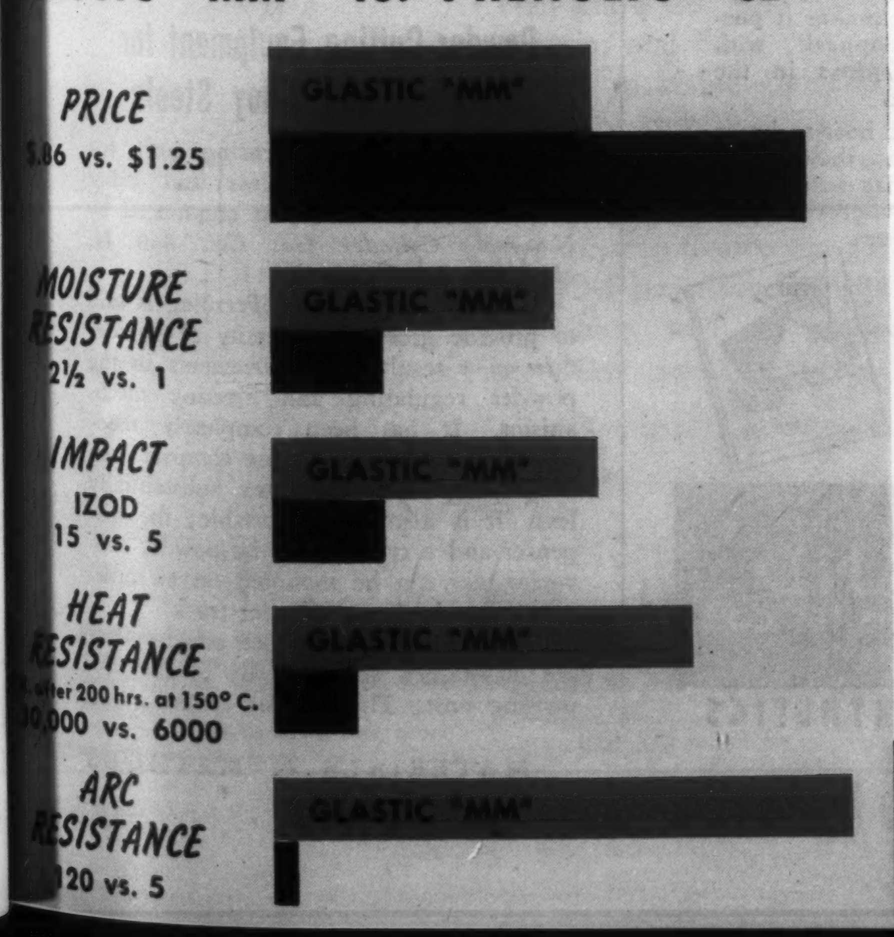
Availability of 75S, highest strength standard aluminum sheet and plate alloy, with a cladding thinner than the normal thickness for regular Clad 75S, has been announced by *Kaiser Aluminum & Chemical Sales, Inc.*, 1924 Broadway, Oakland 12, Calif.

The new sheet and plate are designed to meet the requirements of air-craft manufacturers for better physical proper-

GLASTIC gives you Class 'B' Insulation at Class 'A' Costs!


GREATER DIMENSIONAL STABILITY
HIGHER DIELECTRIC STRENGTH
Glastic Gives You-
NOT MORE FOR MORE
NOT MORE FOR THE SAME
BUT More for Less!
HIGHER IMPACT STRENGTH
LOW WATER ABSORPTION SHRINKING, WARPING
EASY TO MACHINE — PUNCHES CLEAN

GLASTIC "MM" vs. PHENOLIC "CE"



• BETTER INSULATION *at* LOWER COST •

Glastic sheet laminates bring you all this — for less than conventional phenolic laminates. Besides, you have negligible water absorption, easy machining and clean punching; full range of thicknesses from 1/32" to 1-1/4"; in sheet sizes 24" x 36" or 72" x 36". . . . Available also in molded form. . . . Let the Glastic technical staff open the way to a new high in insulation assurance.

• Write for samples and technical information Bulletin M-2 on sheet or molded applications.

THE GLASTIC CORPORATION
1823 East 40th Street • Cleveland 3, Ohio

GLASTIC
ALKYD POLYESTER
Glass Reinforced Plastic

Sicon in colors withstands 500°F.

SICON, THE ORIGINAL SILICONE HEAT-RESISTANT FINISH, IN GLEAMING WHITE AND TAN PROTECTS SURFACE OF HOME INCINERATOR

Here's what the makers of Calcinator say about **SICON**

"In keeping with the high standards we wished to attain for Calcinator, we chose 'Sicon.

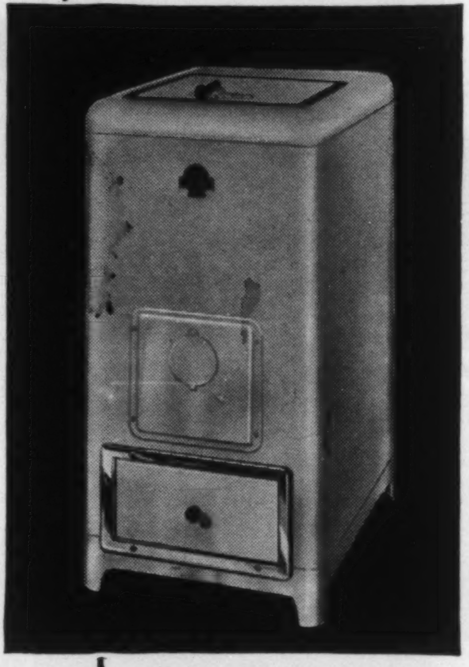
Under rigid perfection tests 'Sicon' was found to have:

1. High resistance to heat when exposed to temperatures ranging from 400 to 500°F.

2. Exceptional color as well as gloss retention qualities.

In addition, only 'Sicon' had good inherent qualities of adhesion and film stability."

W.M. Milbourne, Sales Mgr.,
Calcinator Division
Valley Welding & Boiler Co.,
Bay City, Michigan



Deluxe Calcinator, the home incinerator so smart looking that it can be placed right in the kitchen. Finished in *SICON* White.

Standard Calcinator, for utility room or basement location, features latest advances in incinerators. Finished in SICON Tan.

SICON STANDS UP WHERE OTHER HEAT-RESISTANT FINISHES FAIL!

In case after case, for product after product, SICON has proved to be the *only* heat-resistant finish to pass all tests—in the laboratory and on the production line.

Sicon, in smart decorative colors, now opens up a new horizon for design engineers, because only Sicon makes it possible to combine "eye appeal" with retention of color and gloss in the presence of sustained heat.

No matter how rigid your heat-resistant finish requirement, *try* Sicon, the original silicone-base finish that has revolutionized product finishing wherever high temperatures pose a problem.

Write for brochure and complete engineering details.

Sicon
Silicone-Base Heat-Resistant Finish

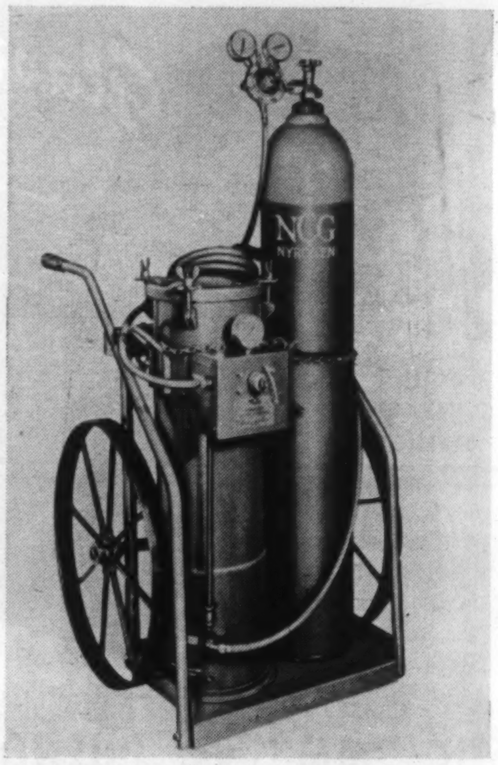
manufactured exclusively by
MIDLAND
INDUSTRIAL FINISHES CO.
Waukegan, Illinois

VARNISHES · ENAMELS · LACQUERS · SYNTHETICS

New Materials and Equipment

ties in some applications, especially where machine tapered and machine sculptured operations are employed, without sacrificing the protection afforded by cladding.

Designated 75S thin clad, this sheet and plate have a nominal cladding thickness of 1½% as compared with 4% for 75S. It is produced in the 0 and T6 tempers in thickness of 0.188 in. and heavier.



Powder-Cutting Equipment for Stainless and Alloy Steels

A new powder dispensing unit for powder-cutting of stainless and other hard-to-cut steels has been announced by *National Cylinder Gas Co.,* 840 N. Michigan Ave., Chicago 11.

The new model, called Ferrojet, is said to provide greater uniformity of powder flow as a result of improvements in the powder regulating and ejecting mechanisms. It has been completely redesigned, is simpler and more compact than the former unit, and costs substantially less. It is also easily portable; the dispenser and a cylinder of the powder-conveying gas can be mounted on an ordinary two-wheel gas cylinder truck.

Gas pressure and rate of powder flow are maintained automatically by the dispensing unit. The powder control valve

Assurance comes at no extra cost with these reinforced plastic materials

There's a valuable premium that arrives with every shipment of Fiber•Glass or resin to certain users of reinforced plastics. It is free to its recipients, but it actually cost several million dollars and many years of many men's time. It is assurance—and it is not as intangible as some practical businessmen might think.

● THIS ASSURANCE is the feeling of well-being that comes to a user, when he knows that the Fiber•Glass, resins and finishes will do what it was claimed they would do—and that one company stands behind them all.

This feeling pays off, not only in physical and mental ease, in fewer gray hairs, but in nice solid dollars. For it means you can think more clearly, act more wisely and proceed efficiently at good speed.

Now we do not hypnotize our customers into this peace of mind, nor does a smooth-talking salesman lull them into this condition. They arrive at it by a most logical process of reasoning.

They know that only L•O•F offers polyester resins and Fiber•Glass, separately or combined in stable compounds for low- and high-pressure molding, with uniformity and quality that do not vary. They know that only L•O•F offers Fiber•Glass with the Garan treatments. They know that only L•O•F has all the background needed to produce and continually improve Fiber•Glass and resins from its half-century of glass experience, its more than 30 years of plastics research (which produced the first commercially successful polyester resin in 1943), and its pioneering in silicone resins.

A user of reinforced plastics can quickly see that this wealth of ability isn't just something for L•O•F to boast about. It means that he, too, can have available to him the technical advice and counsel to guide him in the use of the materials involved in reinforced plastics fabrication.

One more service comes with L•O•F reinforced plastic materials to make up the premium of assurance. It is a vital one, too. It is the sales-promoting activities of L•O•F's promotion team which is ready to help the user of L•O•F materials sell *his* products. This team can see that reinforced plastic products and services are publicized, advertised, and put over to the proper markets.

All these things make up that invaluable bonus of assurance that derives from dealing with an organization that "offers more in reinforced plastics."

PLASKON DIVISION
LIBBEY•OWENS•FORD GLASS COMPANY
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Remember these as your shields, too—protecting you against production losses, giving you better products and helping you sell. For further information call or write your nearest Plaskon representative.

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For design or redesign problems . . . for wood parts in solid or laminated hardwoods (roughed out or finished, flat, turned, shaped, or curved), even plastic-faced materials . . . Gamble Brothers can supply your needs quickly and economically.

Gamble Brothers' more than fifty years of wood-engineering leadership has helped domestic and defense production programs to use wood as wood had never before been used to meet their needs.

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is also automatic, operating simultaneously with the turning on and shutting off of the cutting oxygen valve on the torch.

Both machine and hand cutting torches are available for use with the dispenser.

For use in foundries, a Ferrojet flame washing torch has been developed for the quick removal of riser pads, chill bars, fins, etc. from stainless and other alloy steel castings. The torch is said to be up to ten times faster than chipping and grinding.

New Resin for Plastic Film and Sheeting Industry

Development of a new vinyl resin specifically for the plastic film and sheeting industry has been announced by the *Naugatuck Chemical Div., U. S. Rubber Co.*, Rockefeller Center, New York 20.

The straight polyvinyl chloride resin, known as Marvinol VR-21, has the processing characteristics of the vinyl copolymers and retains the superior and product properties of straight polyvinyl chloride. It is to be used primarily in such products as shower curtains, drapes, upholstery, luggage, pocketbooks and inflatable toys.

The resin can be used to manufacture film and sheeting free of gel particles at processing temperatures 15 to 20 deg lower than those used for other polyvinyl chloride resins. It has a particle size and density which make for a fast solution rate, thus allowing either lower temperatures or shorter processing times.

Another processing advantage claimed for the resin is that it gives dry, fluffy premixes without the use of heat. This advantage makes for easier clean-out of premixing equipment and easier handling in subsequent processing operations.

Molding of Large Polyethylene Sheets Announced

Molding of large polyethylene sheets has been announced by *Resistoflex Corp.*, Belleville, N. J. According to the company, the sheets are made in sizes 36 by 36 in. and from 1/16 to 1 in. thick. Two types are available: straight polyethylene,

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DOLLIN CORPORATION, 610 So. 21st St., Irvington, N. J.

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Fill out the coupon below for your samples of this new, radically "different" Fiber Glass Reinforcing Mat. Users tell us "it's the *most uniform, best colored, most usable* mat material they have ever seen."

UNIFORMAT is now available in 50″ wide rolls up to 150′ in continuous length, and with either high solubility or general-purpose binder, depending on the molding process you prefer. Standard weights are 1½, 2 and 3 ounces per square foot.

UNIFORMAT is produced on a unique machine of our own design which assures uniform weight and texture and provides equal reinforcing strength in all directions.

High-Quality Chopped Strand and Roving Also Available.

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CUSTOM ALLOY POWDERS *for* ALLOY STEEL COMPOSITIONS*
... high tensile strength

*Chromium Nickel Powder
or Nickel Chromium Powder
—combined with electrolytic iron powder

Multiple advantages accrue to you through the use of MH Chrome Nickel alloy powders for Alloy Steel compositions in your powder metallurgy molding —

- volume production of intricate parts having higher tensile strength
- miniaturization of parts with greater strength and less mass
- no scrap or waste no milling or finishing required

Fine particle size is an outstanding feature of MH Chrome Nickel alloy powders, as indicated on the chart below.

TABLE XIII

COMPARISON OF EFFECTS OF HEAT TREATMENT ON PROPERTIES OF ELECTROLYTIC IRON POWDER PLUS ALLOYS OF VARIED NICKEL—CHROMIUM CONTENTS

Compacting Pressure — 50 tsi
Sintering Condition — 1100 C for 1 hour at temperature in hydrogen

MATERIAL	Electrolytic Iron + 1% Graphite + 10% Alloy (80% Ni — 20% Cr)				Electrolytic Iron + 1% Graphite + 10% Alloy (80% Cr — 20% Ni)			
	TENSILE STRENGTH PSI	ELONGATION % IN 1"	ROCKWELL HARDNESS	SINTERED DENSITY G CC	TENSILE STRENGTH PSI	ELONGATION % IN 1"	ROCKWELL HARDNESS	SINTERED DENSITY G CC
Sintered	72200	2.5	R_B83	7.11	66100	2.0	R_B99	6.64
Coined	76300	4.6	R_B85	7.18	63000	2.0	R_B95	6.65
Coined & Annealed	71000	3.5	R_B84	7.15	83000	2.0	R_B95	6.65
Coined & Quenched	76900	1.7	R_C25	7.08	84400	2.0	R_B100	6.65
Coined, Quenched & Annealed	99500	0.5	R_C15	7.08	92900	2.0	R_B96	6.65
Quenched	75800	2.3	R_C19	7.11	84000	2.0	R_B97	6.65
Quenched & Annealed	88650	2.3	R_C16	7.11	77300	2.0	R_B95	6.65

Size Characteristics—(80% Ni — 20% Cr)

	+100	2.4%
−100	+200	31.9%
−200	+325	28.5%
	−325	37.2%

Size Characteristics—(80% Cr — 20% Ni)

−100	+200	4.7
−200	+325	9.7
	−325	85.6

For detailed information, write:

METAL HYDRIDES INC

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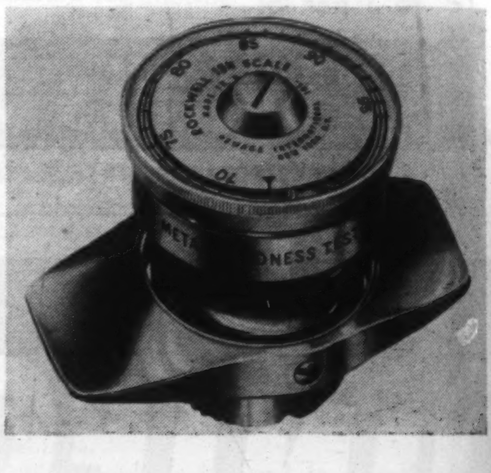
or polyethylene fiberglass fabric reinforced laminates.

The latter construction is said to provide rigidity when applications require extra strength in addition to the chemical, physical and electrical properties of polyethylene. Its tensile strength is claimed many times greater than that of unreinforced polyethylene. The reinforced material permits the fabrication of relatively small thin wall self-supporting structures.

According to the manufacturer, joints can be made by heat forming and sealing.



Superficial Portable Metal Hardness Tester Offered

A new Ernst tester which is said to permit metal producing and metal working plants to obtain superficial readings with a portable instrument is currently being offered by *Newage International Inc.*, 235 E. 42nd St., New York 17.

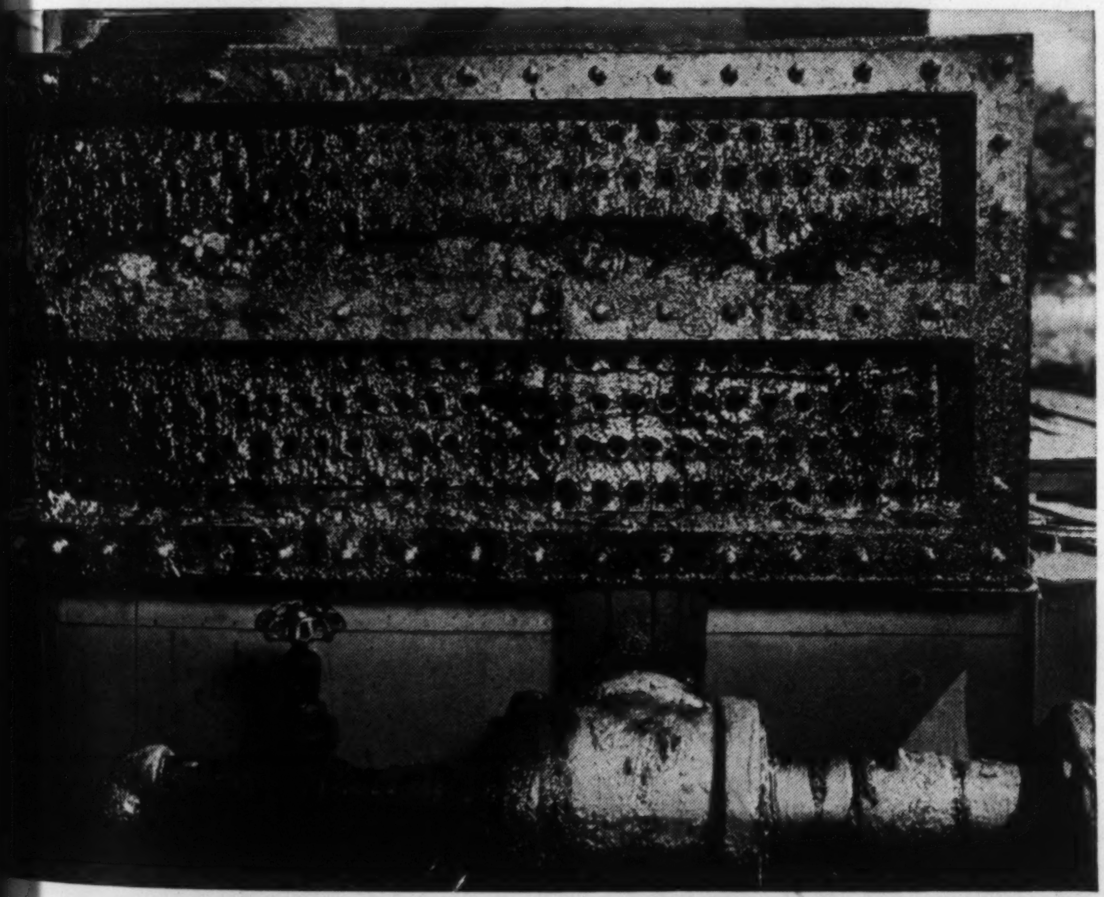
The tester gives direct dial reading in Rockwell 15N Scale, 70-95. Accuracy is said to be guaranteed by individual assembly and individual calibration of each instrument against certified laboratory standards.

Three factors make the instrument ideal for testing small parts and finished pieces: low load; small indentation; minute diameter of penetration. It is also extremely easy to use. The operator simply places the tester on the material to be tested, presses downward on the handgrips, and a direct reading is obtained on a large, easily read dial.

A new design principle eliminates the old base-plate or pressure-screw clamp attachment design of other testers, making possible the testing of any size, shape and type of metal almost without limit.

(Continued on page 157)

THIS PLANT QUENCHES ALL TYPES and sizes of automotive and aircraft forgings. Sun Quenching Oil Light serves all five of the 2400-3000 gallon systems. In the seven years the shop has been using this oil, no unit has been down except for normal mill scale removal.



AN OIL THAT FORMS SLUDGE CLOGS oil coolers, increases maintenance and operating costs. Sun Quenching Oils have a natural detergency which helps keep the systems clean and removes any deposits that may exist.

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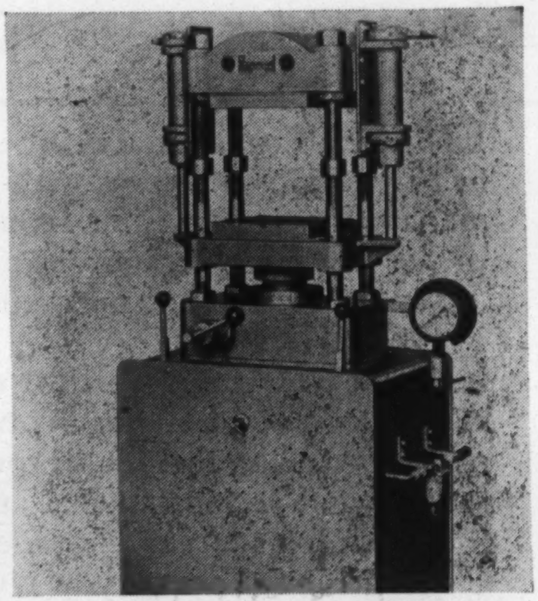
The unit has a spring-loaded diamond penetrator indentor. Readings appear on a 2-in. dia scale. To take a hardness measurement, the handgrips are pressed downwards. This action lowers the indentor housing to bring the under surface of the tester against the surface of the material to be tested. After which, further depressing of the handgrips ensures that the point of the indentor penetrates the surface of the test material under the action of the carefully calibrated helical spring. The movement of the indentor as it penetrates the material slightly compresses the diaphragm of a fluid-filled chamber. Fluid is thereby forced further into the capillary tube, which encircles the dial, to indicate the hardness number on the dial scale. The movement of the indentor into the material is magnified about 3000 times by the fluid displacement in the capillary tube. The final position of the fluid indicates the hardness value directly on the scale.



Light-Weight, Low Cost Plastic Molding Presses Offered

Hydrolairs—small, light-weight, inexpensive plastic molding presses which take their power entirely from the shop air line—are currently being offered by *Elmes Engineering Div., American Steel Foundries,* 1150 Tennessee Ave., Cincinnati 29.

The press illustrated here is a special modification of the standard design. It has a 30-ton capacity and is equipped with air-operated pushback cylinders for powered ram return. This particular unit was made for continuous production of

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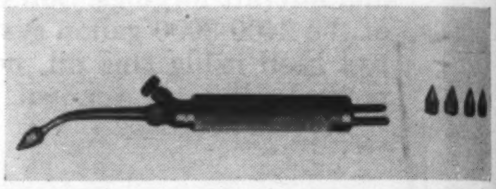
molded cord and plug sets for electrical appliances.

According to the manufacturer, Hydrolairs greatly reduce production costs. They are fast and full power-operated, with high-pressure stroke, yet without the usual motors and pumps. Selected pressure is automatically applied and maintained, even on compressible materials.

In addition to the 30-ton model illustrated, the units are available in the standard 50-ton floor model with either lever or electrical control, and in 30-ton bench and floor models with lever control only.



Small Torch Produces Pin Point Flame

A percision built torch only 7½ in. long and ¾ in. in dia which handles with the ease of a pencil, has been announced by *Micro-chemical Specialties Co.*, 1834 University Ave., Berkeley 3, Calif.

The torch uses oxygen and gas or oxygen and acetylene to produce a pin point flame capable of welding up to 3/16-in. round iron. Finger tip mixture controls provide for fine adjustment of flame.

The instrument comes complete with 0.004-in., 0.015- and 0.020-in. bore diameter tips; other tips are from 0.004 to 0.030 in. in dia.

The new unit is claimed to be excellent for working quartz fibers, fine pyrex glasswork, small scale silver soldering, brazing and welding.

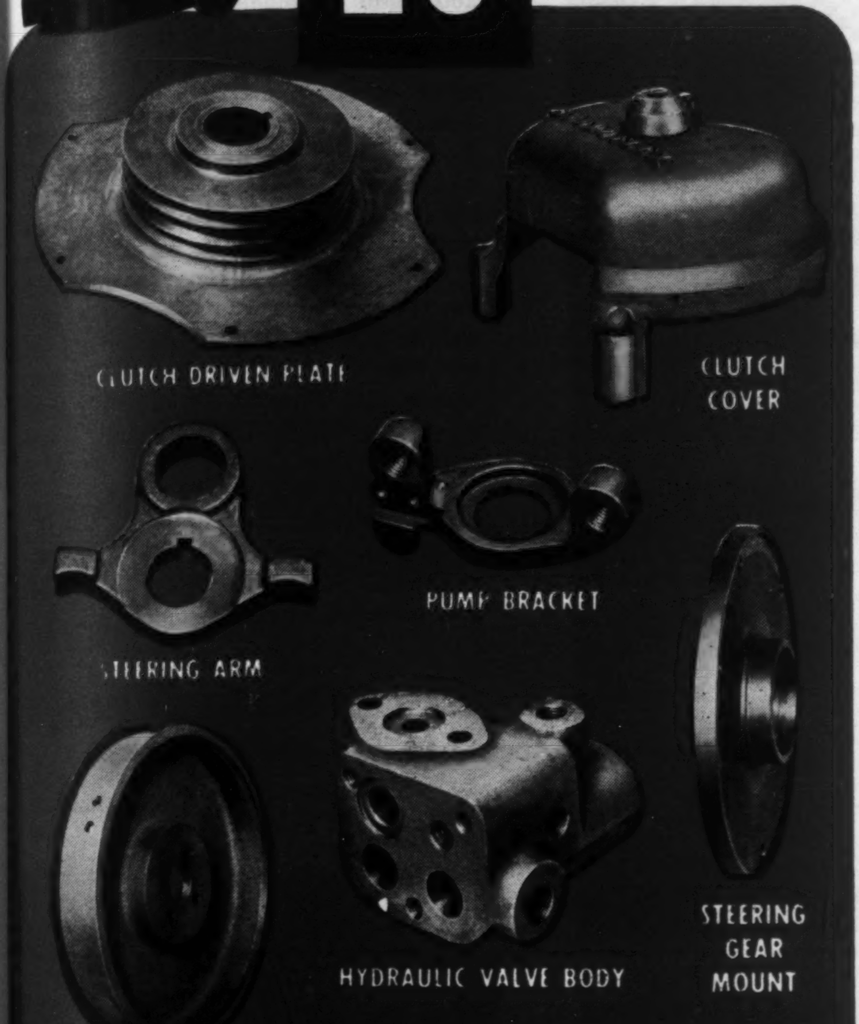
Universal Tester Designed for Large Specimens

A new floor-type, universal testing machine permitting great working capacity on a finished machine pad bed of 4 by 15 ft has been announced by *Young Testing Machine Co.*, Bryn Mawr, Pa.

Designed especially for large speci-

Fig. 1

23 MEEHANITE Castings in this HiDUTY Lift Truck



TRANSITIER Truck Co., Portland, Oregon, specify 23 important cast components in their line of HiDuty Lift Trucks (Fig. 1) in Meehanite metal. The importance of these parts is further emphasized by the fact that in recent months a number of them have been redesigned from original steel and bronze specifications. In addition to the ones shown, the following parts are Meehanite castings:

1. **WHEEL SPACER**
2. **HYDRAULIC VALVE BODIES(2)***
3. **CLUTCH DRIVEN PLATE**
4. **CLUTCH SUPPORT**
5. **TRANSMISSION CASE**
6. **BRAKE DRUM**
7. **WHEEL HUB(1)***
8. **HYDRAULIC CYLINDER PACKING NUT (2)***

**In addition to similar parts shown.*

The design and specification of these components is a good example of the beneficial results of team work between a foundry manufacturing high property, high quality castings, and a manufacturer alert to the possibilities of incorporating dependability into his product through proper specification. The use of Meehanite castings provides a sure knowledge that both service and production requirements will be met regularly and repeatedly.

Write for our new Bulletin 35 "Meehanite Castings Serve all Industry."

Take *YOUR* Casting Problem To A MEEHANITE FOUNDRY

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Toledo, O.
Builders Iron Foundry	Providence, Rhode Island
Compton Foundry	Compton, Calif.
Continental Gin Co.	Birmingham, Alabama
Crawford & Doherty Foundry Co.	Portland, Oregon
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio, and Grove City, Pa.
De Laval Steam Turbine Company	Trenton, New Jersey
Empire Pattern & Foundry Co.	Tulsa, Oklahoma
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Hardinge Company, Inc.	New York, New York
Hardinge Manufacturing Co.	York, Pennsylvania
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Koehring Company	Wilwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
London Concrete Machinery Co., Ltd.	Brantford, Ontario
E. Long Ltd.	Orillia, Ontario
Otis Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Palmyra, New Jersey
Palmyra Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Denver, Colorado
The Stearns-Roger Manufacturing Co.	Worcester, Massachusetts
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
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Detroit Ave. at W. 93rd St., Cleveland 2, Ohio

mens of work such as bridging members, aircraft wings and concrete columns, this 200,000-lb machine offers a number of new features.

The crosshead is driven by a Thymotrol motor mounted directly on the crosshead instead of at the bottom of the machine. Raising and lowering of the crosshead on fixed screws thus permits a more direct and rigid drive with considerably less torsion in the screws. Speed range of the motor is 20:1, providing an overall loading speed of 0.025 to 0.5 in. per min. and a high traverse speed of 15 in. per min. Special flexure plate construction in each plane allows eccentric loads to be used. Welded steel, fully stress relieved, is used throughout.

Originally developed to answer the needs of a large Eastern university, this machine is now available to industry in the general price range of standard table-type universal testing machines.

Spray-On Dye Penetrant Inspection Offered

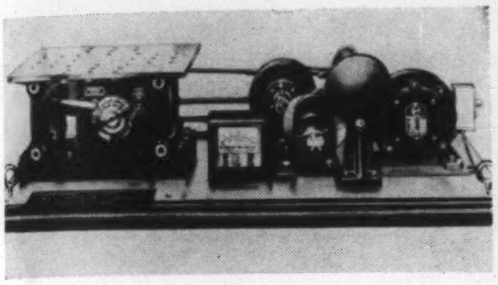
A more reliable dye penetrant test to locate cracks in any solid material has been announced by *Magnaflux Corp.*, 5900 Northwest Highway, Chicago 31. A packaged kit is available for inspection of small questionable areas and remotely located parts. Features include spray can sealing of messy constituents, for cleanest and most conveniently rapid spray application to any part.

For plant maintenance of mechanical equipment or for tool inspection in any industry, for weld, casting or forging inspection, or for overhaul tests of any transportation equipment, the Spotcheck kit is carried in one hand to the parts in question, and tests for cracks are carried out in a few minutes.

The dye penetrant is pressure-can sprayed on the clean surface to be tested. Then a cleaner is sprayed on the surface,

New Materials and Equipment

and removed by a quick wipe. An even coat of white developer is brushed on and inspection follows in a few seconds. Cracks show up as bright red lines, and pores or leaks in tanks show as bright red spots.



Improved Vibration Fatigue Testing Machine

An improved version of the Model 100 HA, the model 100 HL-A fatigue testing machine is currently being offered by *All American Tool and Manufacturing Co.*, 8027 Lawndale Ave., Skokie, Ill.

Outstanding among improvements is said to be the method of table support. Four linkage arms, equipped with ground steel pins and Super Oilite bushings support the table; a method proved more efficient and serviceable. Ball tracks have been eliminated. Bearing contact is said to have been increased fivefold. Another improvement, the table has tapped mounting holes, jig-drilled in a symmetric pattern, so that the object being tested (or fixture for holding the object) can be turned 90 deg. This pattern also permits interchangeability of fixtures between models of same load rating.

With this machine, the type of horizontal vibrations to which a part or product will be subject when in use can be simulated, and the ability of the part or product to withstand those vibrations readily determined. The machine can be set to produce vibrations of constant frequency or to repeat cycles of graduated frequency.

Paint-On Solder Paste-Flux Combination

A new paint-on solder paste combined with flux, trade-named EutecTinWeld. which is said to increase speed of appli-

New ChemoTec bonding agents

join metal to metal... or metal to non-metals... without heat... without pressure... at low cost!

Now, with these amazing new organic bonding agents, you can join similar metals . . . or dissimilar metals . . . or metals to non-metals . . . quickly, easily—at extremely low heat or no heat at all!

What's more, simple contact-pressure is enough to form a *permanent, porosity-free* bond with tensile strengths exceeding those of many solders! Now you can design and produce — AT LOW COST — such previously "impossible" combinations as:

TITANIUM TO MAGNESIUM TO ALUMINUM • METAL TO GLASS TO CERAMICS • STEEL TO RUBBER TO BRASS • WOOD TO LEATHER TO COPPER — *and scores more!*

The bonding of "fin-tubes" on heat transfer equipment such as this has up to now presented an almost insurmountable metal-joining problem. Today, the extraordinary thin-flowing characteristics of ChemoTec permit it to penetrate to the desired areas by capillary action. Thus, swift and efficient bonding is obtained .. with excellent color match . . . with tensile strength that more than meets specifications . . . at substantial savings in time, labor, and materials!

Tensile strengths exceeding 5000 psi. • Low labor costs • Excellent capillary action • Free flowing Low cost • Heat not essential • No annealing of base metal • Perfect heat control • No galvanic action • No porosity • Pressure not essential Perfect insulation • No corrosion • No flux needed Economical in mass production

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ChemoTec Bonding Agents are available in liquid, paste, powder or rod form to answer every production need. Send for FREE illustrated literature, technical data, etc., to see how these new developments can help solve YOUR joining headaches . . . today!

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EUTECTIC WELDING ALLOYS CORPORATION **MM-2**
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These new ChemoTec Bonding Agents sound interesting. Without cost or obligation, send me FREE illustrated literature and further information about how they can be adapted to my specific production needs.

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Taking the frame temperature of a 300 amp. aircraft generator on test at the Stackpole brush laboratories

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Stackpole brushes are sold only to producers of original equipment—not for replacement uses.

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St. Marys, Pa.

STACKPOLE
BRUSH USER'S GUIDE

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This 44-page Stackpole Brush Users' Guide contains a wealth of helpful data on factors pertaining to brush selection and use. Copy sent on letterhead request.

STACKPOLE

BETTER BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT

New Materials and Equipment

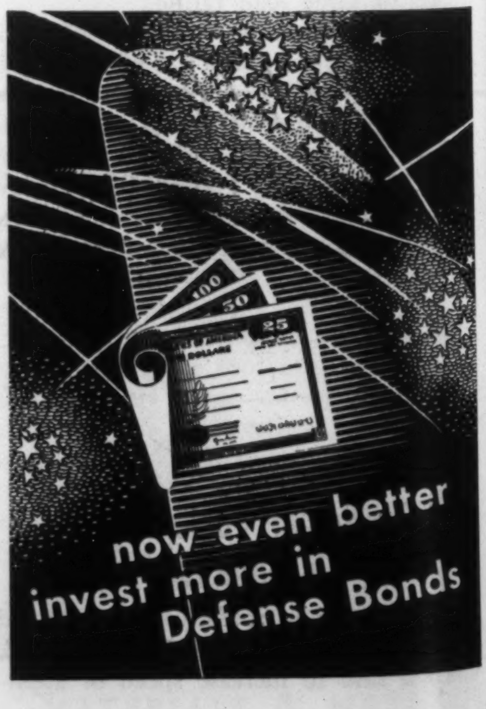
cation while cutting waste, has been announced by *Eutectic Welding Alloys Corp.*, 40-40 172nd St., Flushing, N. Y. The new product, which can also be used as a tinning compound in paste form for all tinning operations, is reported to be ideal for production and repair items and for intricate parts where conventional methods are impractical.

Basically, the new product consists of a specially formulated lead-tin-solder that is pre-mixed, in paste form, in proper proportions with its specially compounded accompanying flux. The resultant product is said to yield a capillary flow similar to silver solder with strengths equivalent to conventional lead-tin solders, while completely eliminating the waste and awkwardness involved in melting solder off a stick or coil in the ordinary way.

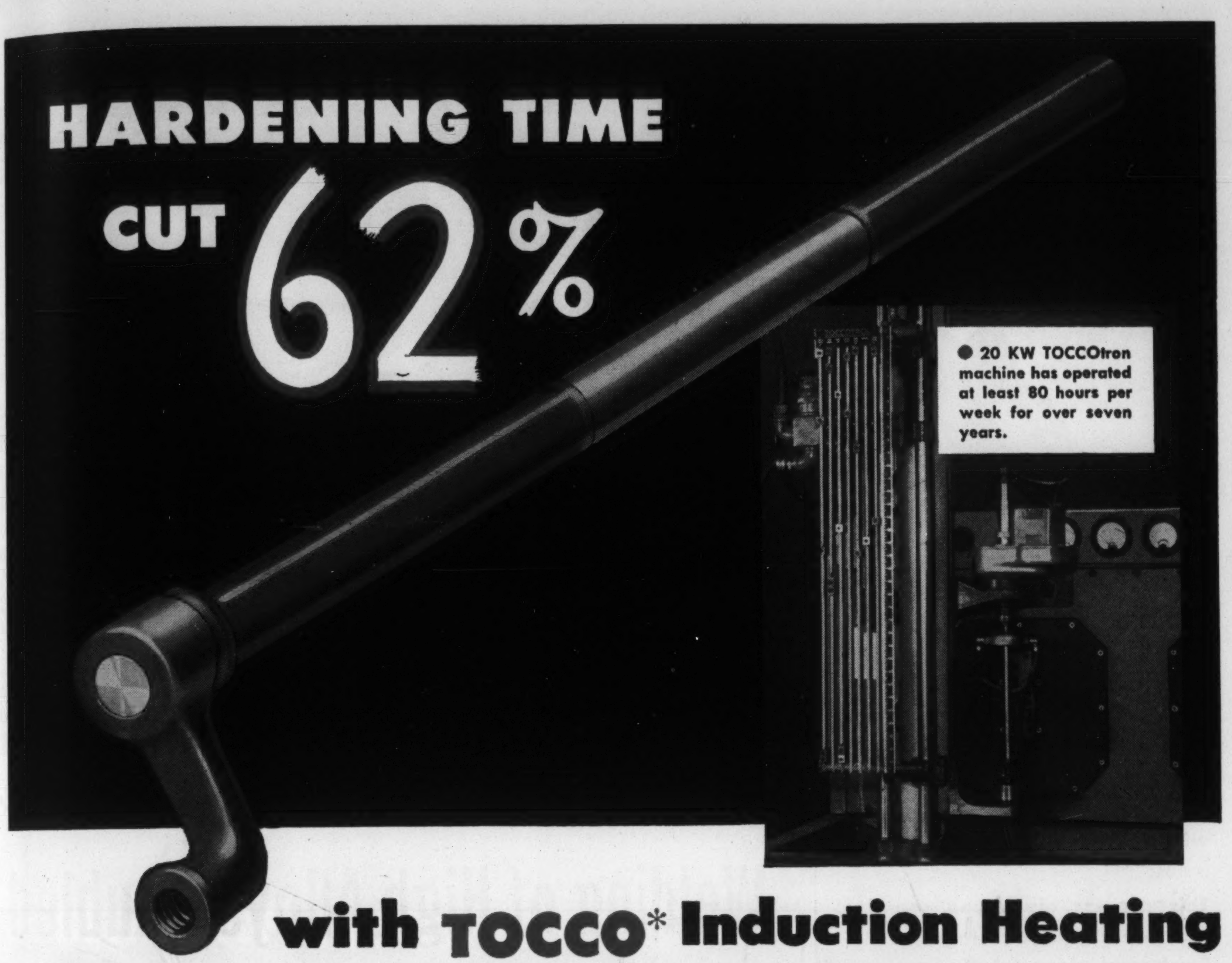
Whatever small amount of flux residue may result from the TinWeld paste application can swiftly and easily be washed off with plain water, thereby easily preventing corrosion, according to the company.

Since the new formulation permits brush, spatula or dip application, it is claimed to be ideal for work where preplacement of alloy is required for furnace, automatic soldering, and similar operations; for tinning on auto body work; for tinning of odd shaped parts normally difficult to reach with a solder in wire form; for delicate work requiring small amounts of alloys, such as jewelry, etc.

TinWeld can be used with torch, furnace or soldering iron to join all metals except aluminum and magnesium. No additional or outside flux is required.



HARDENING TIME CUT 62%



● 20 KW TOCCOtron machine has operated at least 80 hours per week for over seven years.

with TOCCO* Induction Heating

When minutes saved mean dollars earned, look to TOCCO Induction Heating

●Singer Manufacturing Co., makers of famous Singer Sewing Machines, reports the following results when they switched to TOCCO—hardening the shaft assemblies shown above. Note the operations eliminated through the use of TOCCO and the savings of 151.8 minutes per 100 parts.

OLD METHOD		TOCCO METHOD	
Operation	**Min./100 Pcs.**	**Operation**	**Min./100 Pcs.**
Assemble on plating racks	23.0	eliminated	
Copper plate crank end	43.0	eliminated	
Remove from plating racks	15.0	eliminated	
Harden shaft and anneal crank	120.0	TOCCO harden and clean	92.5
Strip lead	10.0	eliminated	
Strip copper and clean	33.3	eliminated	
Old method total time	244.3 minutes	TOCCO method total time	92.5 minutes

Have you investigated TOCCO's time and cost savings possibilities for your hardening, brazing, forging or melting operations? It will pay you to write or send blueprints of your parts for analysis—no obligation of course.

see our CATALOG in SWEET'S FILE MECHANICAL INDUSTRIES

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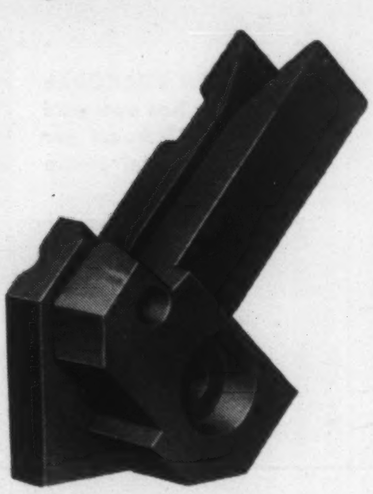
Investment Casting shows the way



Once again Investment Casting has guided a customer to better parts at lower costs.

The illustrated guide is cast in SAE 4130 material complete with exception of reaming the holes.

This process gives you sound pressure castings with smooth finish and close tolerances.

We are fully equipped to handle any ferrous or non-ferrous casting alloy.

Investigate today the possibility of eliminating costly machine operations on your small parts.

Our Engineering Department is always available to help you get a better part at lower costs.

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Small precision castings of ferrous and non-ferrous alloys.

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Please send me literature on Precision Investment Castings.

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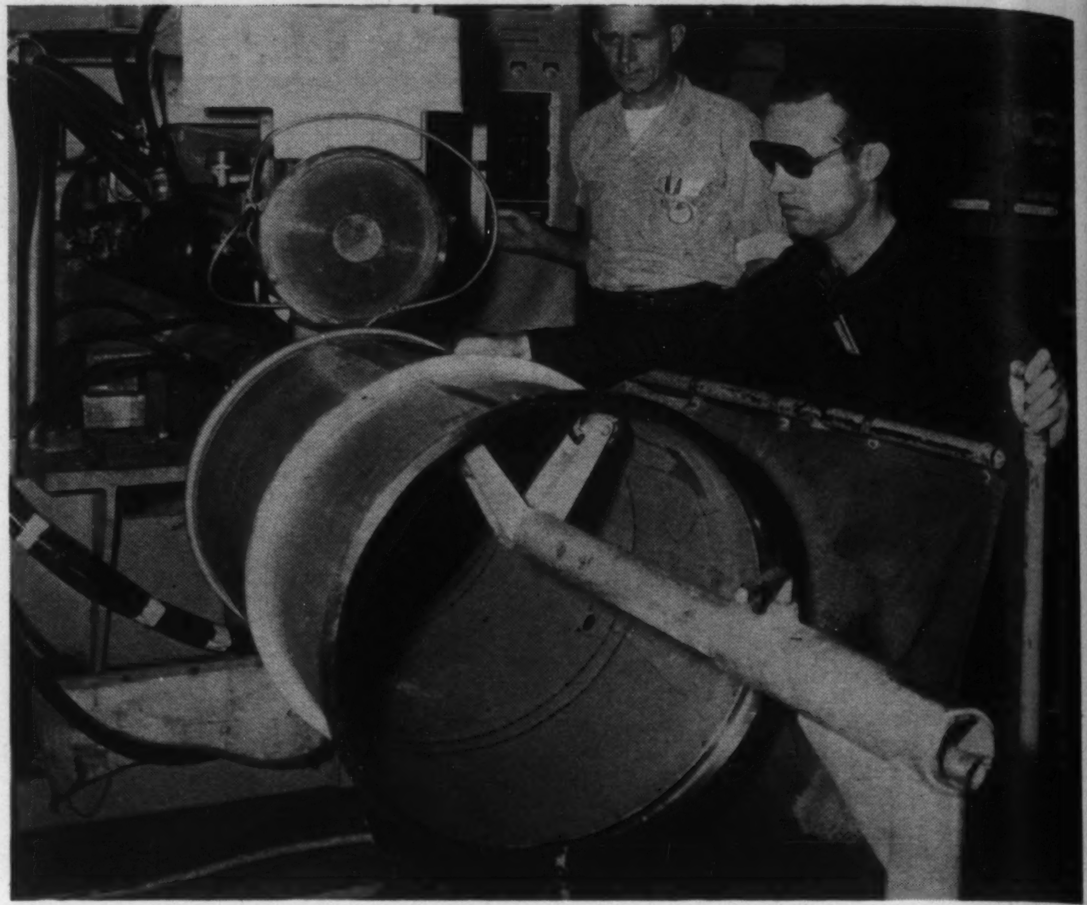
COMPANY ....
ADDRESS ....
CITY ....ZONE... STATE.....



Jet engine tail pipe being spot welded at 68 in. per min, three times the former rate. (Ryan)

Welding of High Alloys Doubled with New Roll-Spot Technique

By J. R. FULLERTON,
Welding Engineer, Development Laboratories, Ryan Aeronautical Co.

Improved weld quality and increased welding speeds are achieved by modifying the drive mechanism of standard seam welders.

● WITH A NEW technique and modified facilities, Ryan spot welding engineers have stepped up welding speeds more than 100% and, at the same time, improved weld quality. Gas-tight seam welds are in production at 26 in. per min, compared with speeds of between 6 and 12 in. per min formerly achieved. Spot welds on 1-in. spacings can be installed at 68 in. per min, in contrast to the former rate of only 21 in. per min.

This accelerated performance is attained in the welding of stainless steels, Inconel X and W, Haynes Stellite No.25 and other crack-sensitive alloys used in the fabrication of afterburners, variable nozzles, exhaust cones, tail-pipes and high temperature jet engine components.

New Indexing Device

Taylor-Winfield machines which have been equipped with fast-indexing mechanisms for roll-spot welding are used. These devices are air-operated, electronically-controlled units consisting of two horizontally-opposed bellows which actuate an overriding clutch. Powered by standard air line pressure of 80 psi, the clutch rotates the upper wheel electrode of the machine. By pressing a switch

(*Continued on page* 168)

Half-soles for a Behemoth . .

SHARON* HI-STRENGTH STEELS DELIVER MAXIMUM STRENGTH FOR TANK TRACKS

Tank parts must absorb a lot of punishment. Rough terrain, twisting directional turns, cannon recoil, quick starts and stops are a few of the reasons why modern tanks must take it.

To overcome failure through metal fatigue designers today are specifying that most parts of this vital mechanism be constructed of hi-strength steels. As a leader in the production of such special alloys Sharon has had a large part in the production of hi-strength steels for military purposes.

These same Sharon hi-strength steels are becoming increasingly available for product improvement for civilian consumption. If you're in the market for tough steels that will do more, talk to the Sharon man in your area.

*Specialists in STAINLESS, ALLOY, COLD ROLLED and COATED Strip Steels.

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Sharon, Pennsylvania

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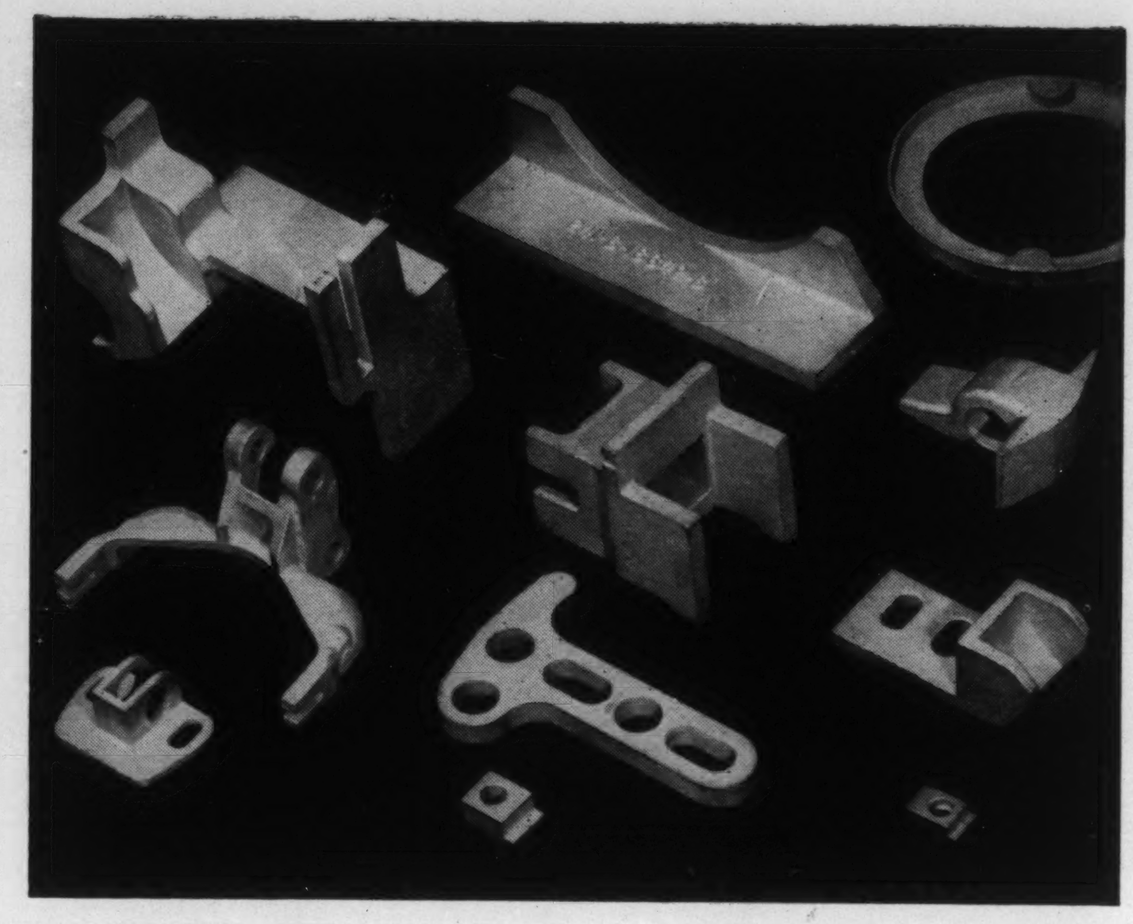
For information on Titanium contact Mallory-Sharon Titanium Corp., Niles, Ohio

SHARONSTEEL



"..accuracy and excellence of workmanship found only in exceptional organizations."

Dalmo-Victor Company of San Carlos, California, makers of electronic equipment, have that to say about Precision Metalsmiths. Pictured above are a few of the *investment castings* which have earned this high compliment.

Their further comment, "We are expecting a large increase in our use of such castings", is a thought heard often after manufacturers have discovered these facts: Intricate parts, not possible with any other process, can be investment-cast; designers can let their imagination run wild. Many machining and assembly operations can be eliminated and, often, parts are made in alloys that can't be machined.

Investment castings save you money, too: 21¢ against a previous 69¢—75¢ compared to a former $2.17—$2.80 for a part that would cost at least 3 to 4 times that much by the next cheapest process—$10.50 for a part made in one piece which couldn't be made by any other method.

Say "when"

you're worried about high costs

and we'll send you this free book

PRECISION METALSMITHS, INC., 1081 East 200th St., Cleveland 17, Ohio

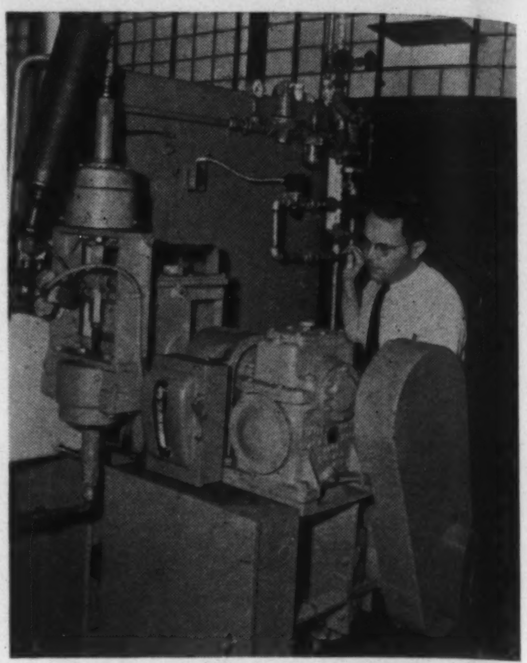
pour yourself an assembly with

PRECISION METALSMITHS INC.

INVESTMENT CASTINGS

Welding of High Alloys . . . .

continued from page 166



Air-operated bellows-type control replaces standard electric drive to increase welding speeds. (Ryan)

the continuous electric seam welding drive mechanism is detached and the roll-spot drive is engaged. It can be set by indicator to index in single or multiple movement and spot weld at spacings from 0 to 5 in.

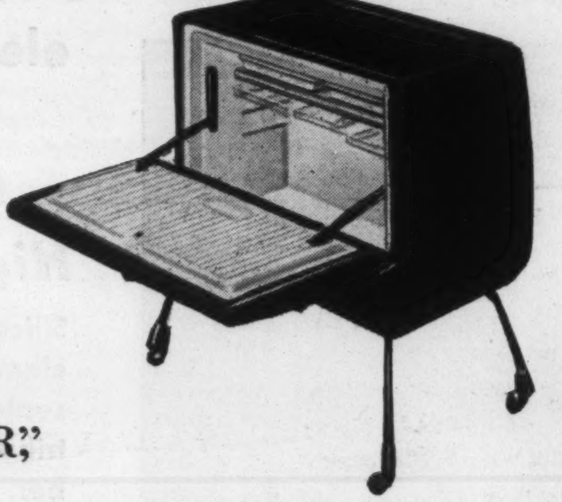
The new controls are a distinct advantage over the Geneva-type drives used heretofore. With the Geneva drive, limited flexibility is available because the proportion between the dwell time and indexing time is a fixed ratio, depending upon the gearing and drive mechanism. It can be varied in fixed increments only. The Taylor-Winfield air-operated drive provides infinite flexibility in varying dwell and indexing time ratios.

Although the new mechanism was developed to accomplish spaced out spot welds at increased speeds, faster seam welding has also been achieved. With continuous drive machines, certified, gas-tight seam welds cannot be formed at speeds exceeding 6 to 12 in. per min in the crack-sensitive alloys. When these rates are exceeded, the metal temperature rises sufficiently to produce excessive shrinkage, and distortion and cracks develop.

Analysis of this phenomenon showed that a large number of overlapping spot welds were required to produce gas-tight seams with continuously rotating electrodes because each spot weld was inferior to that produced under static conditions. Consequently, efforts were directed toward attaining the speediest intermittent operation commensurate with high quality. This was accomplished by further modification of the drive mechanism.

(Continued on page 170)

PLASTICS ADD SALES APPEAL



STYRON gives additional Beauty and Utility to new SERVEL "ELECTRIC WONDERBAR," portable refrigerette

With the handsome new Electric Wonderbar, Servel has created a unique and happy combination of utility and styling. This remarkable portable refrigerette is right at home in the living room, nursery, or as a TV snack spot in the recreation room. It freezes its own ice cubes and is an ideal refreshment center for the family. Doctors and other business executives will find the Servel Electric Wonderbar a useful piece of office equipment, too.

In creating the Electric Wonderbar, Servel used Styron for many of the essential parts. Because Styron (Dow polystyrene) is a durable, odorless, easy-to-clean plastic with excellent insulating properties, it offered a threefold advantage of utility, beauty and sales appeal.

Perhaps plastics can improve your product too; why not work together with experts from Dow's Plastics Technical Service and an experienced molder to give your new product, or present ones, more buy-appeal at the point-of-sale? Write today.

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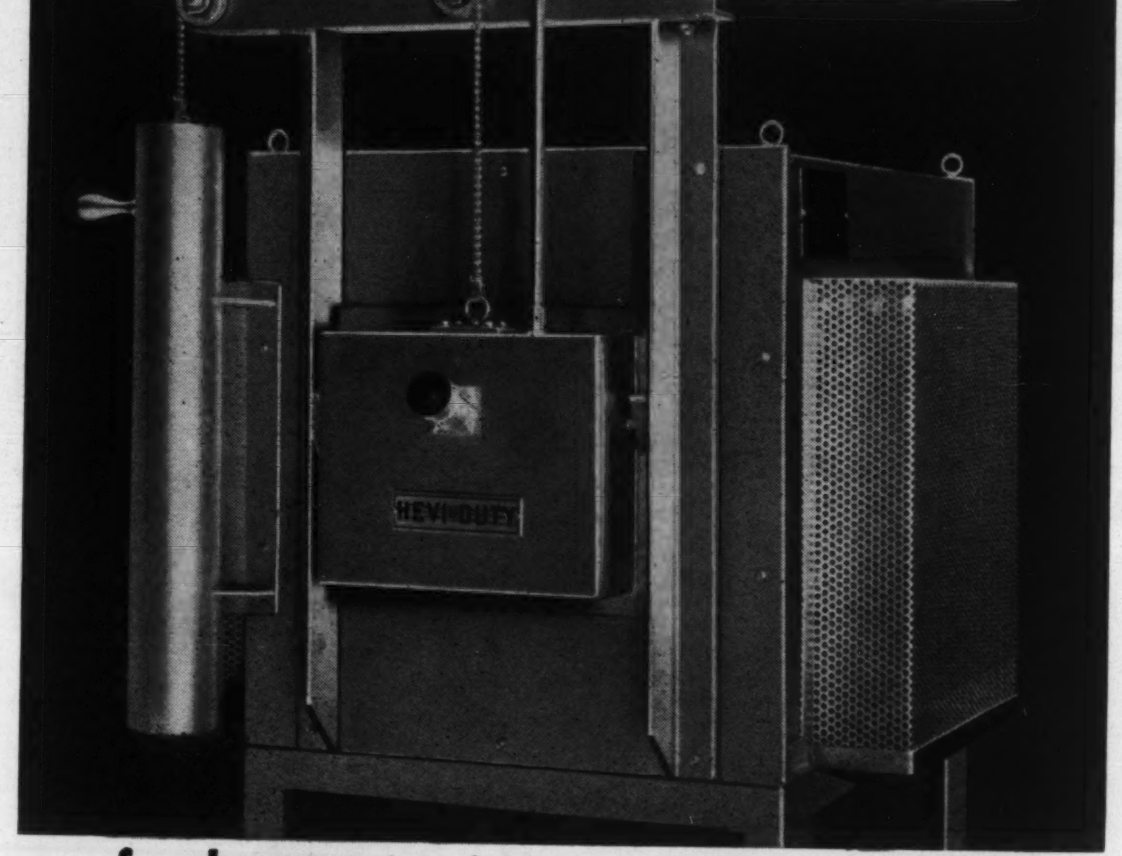
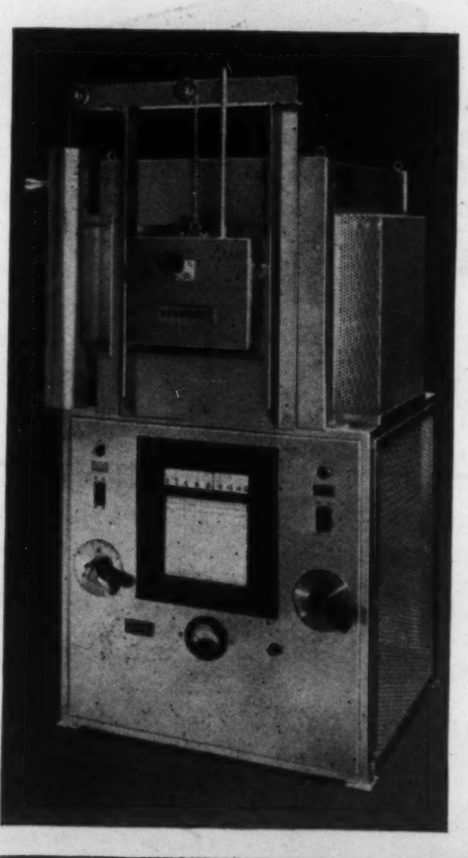
TEMPERATURES TO 2600° F.

with a **HEVI DUTY**
G-8156 HIGH TEMPERATURE
BOX FURNACE



. . . for heat-treating operations requiring



elevated temperatures for *RESEARCH CERAMICS* and High Speed *STEELS*

Silicon Carbide (* Globar) heating elements located above and below a sealed muffle assure even heat distribution throughout the work chamber. Connections for using a protective atmosphere are provided.

The furnace is available in several sizes with or without the control base as shown in the insert. Transformers, pyrometer and circuit breakers can be supplied as required.

Write for bulletin HD-741

*** trademark, Carborundum Co.**

HEVI DUTY ELECTRIC COMPANY
HEAT TREATING FURNACES HEVI-DUTY ELECTRIC EXCLUSIVELY
DRY TYPE TRANSFORMERS — CONSTANT CURRENT REGULATORS
MILWAUKEE 1, WISCONSIN

continued from page 168

With the improved drive, new performance ratios were developed in which time was compressed to the minimum. Dwell time, during which the electrodes are motionless, was reduced to the shortest possible interval consistent with sound-spot weld structure. Indexing time, which is time lost in advancing to the next spot weld location, was also cut to the minimum. Because of the flexibility of the equipment, these time ratios could be coordinated for different materials and thicknesses with complete freedom.

Better Welds Obtained

Once precision control of intermittent operation was attained, it was found that better spot welds could be accomplished than under continuous operation. The weld nuggets were sounder because the metal was held under forge pressure during the cooling cycle and a larger, stronger nugget was made. By holding the sheets during cooling, shrinkage and distortion from heat were reduced.

With sounder spot welds available, it became evident that gas-tight seam welds could be formed with fewer spot welds and at greater speeds. For instance, on a typical Ryan afterburner assembly formed from two sheets of 0.045-in. Inconel W, 11 overlapping spot welds per running inch were required previously to form certified seams under continuous drive. Because of the proximity of the spot welds, this work could not be done at speeds exceeding 12 in. per min due to the heat accumulated. With the new roll-spot technique, certified seams are produced with only 5½ spot welds per in. at the rate of 26 in. of seam per min.

For spaced out spot welding, the new technique is equally satisfactory. In spot welding a General Electric J-47 jet engine tail-pipe, 300 spot welds are made on 1-in. centers in one seam. These can be produced at 68 in. of seam per min, compared with the former rate of 21 in. per min. With improvements now being developed, speeds of 80 in. per min will be realized. This reduction in time permits the spot welding of five of these assemblies in the same time required to do two with older method.

Economically, the innovation presents an attractive picture. The accessory drive costs about 15% of the cost of a new machine, but practically doubles the capacity of the machine on which it is installed.

PRODUCT—
Automotive heater shut-off valve
MATERIAL—
Aluminum alloy
EQUIPMENT—
160 kv x-ray machine

What's the right X-ray film?

KODAK INDUSTRIAL X-RAY FILM, TYPE A

A big production run was scheduled. So to check casting methods, pilot castings were radiographed to detect any recurring porosities.

For these exposures, the radiographer used 70 kv, 54-sec. exposure at 36-in. tube distance—no lead screens—and Kodak Industrial X-ray Film, Type A.

This film is the first choice for examination of light alloys with short exposures at low voltages. It also has high contrast with fine graininess and speed enough to take full advantage of high kilovoltage equipment in radiographing thick or dense materials.

A RIGHT FILM FOR EVERY PROBLEM

Whatever your radiographic problem, you'll find the best means of solving it in one of Kodak's four types of industrial x-ray film. This choice provides the means to check castings and welds efficiently, offers optimum results with varying alloys, thicknesses and radiographic sources.

Type A—has high contrast and fine graininess with adequate speed for study of light alloys at low voltage and for examining heavy parts at intermediate and high voltages. Used direct or with lead-foil screens.

Type M—provides maximum radiographic sensitivity, with direct exposure or lead-foil screens. It has extra-fine grain and, though speed is less than Type A, it is adequate for light alloys at average kilovoltages and for much million- and multi-million-volt work.

Type F—provides the highest available speed and contrast when exposed with calcium tungstate intensifying screens. Has wide latitude with either x-rays or gamma rays when exposed directly or with lead screens.

Type K—has medium contrast with high speed. Designed for gamma ray and x-ray work where highest possible speed is needed at available kilovoltage, without use of calcium tungstate screens.

Radiography... another important function of photography

RADIOGRAPHY
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A wealth of invaluable data on radiographic principles, practice, and technics. Profusely illustrated with photographs, colorful drawings, diagrams, and charts. Get a copy from your local x-ray dealer—price, $3.

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To determine your requirements Roto-Finish maintains a completely equipped laboratory which can (and does) process parts to your specifications. The results we obtain are guaranteed to be duplicated in your plant. This sample processing service is yours without obligation. Just send a few unfinished parts . . . along with a finished part as a guide, for prompt recommendation of the correct Roto-Finish process that exactly fits your requirements.

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News Digest

continued from page 13

bilizers, rust inhibitors, colors and fillers have been added.

By a single cold dip, Gatto described how cold dip plastic coatings ranging from a fraction of a mil to 60 mils could be deposited. Preheating the object to be coated enabled coatings up to 1/8 to 1/4 in. For complete cure, heating by means of infra red lamps or other means converts the plastic coating into a solid state.

Among the advantages Gatto pointed out were: No special dipping tanks are needed with the cold dip; hazardous hot material is avoided; no deterioration of compound is apparent no matter how long it is used; there is no need for emptying and cleaning dipping tanks; and because the product does not have to be heated for applying, various types of rust and corrosion inhibitors can be utilized without fear of loss due to volatility. He concluded that the fused coating is equal to and in many ways far superior to the hot dip materials.

Dr. G. O. Inman of the Rock Island Arsenal told the conference how the government has developed specifications and cited recent moves to simplify and consolidate. A Subpanel on Specification Review for Consolidation has successfully consolidated 17 corrosion preventive specifications comprising 21 grades into three specifications of seven grades.

Charles W. Griffiths, assistant director of Government and Industrial Research of the Hollingshead Corp., discussed the functions of corrosion preventives, suggested a simple system of classification, and the important considerations in the selection of the proper corrosion preventives. The three classes suggested were: (a) solvent types, (b) grease types, and (c) oil types.

A description of each type, together with its advantages and limitations, and formulation information of a general nature was presented. Considerations suggested to aid in the selection of proper corrosion preventives were:

1. Protection properties desired
2. Ease of application and removal
3. Chemical and physical stability under conditions of use
4. Chemical inertness toward parts to be protected

U. S. DRILL HEAD COMPANY SAYS . . .

HEAT TREATING ELIMINATED

- REJECTIONS REDUCED
- WEARABILITY INCREASED AND

COSTS CUT 50%

WITH

STRESSPROOF®

SEVERELY COLD-WORKED, FURNACE-TREATED STEEL BARS

Multiple spindle, made by U.S. Drill Head Company, Cincinnati, Ohio, uses spindles made from STRESSPROOF.

- Spindles for these multiple drill-heads must be straight. Formerly heat-treated, straightening was a difficult, costly job, and rejections were high.

Now produced from STRESSPROOF, heat-treating, with its attendant straightening problem, is eliminated; machinability is increased 25%; wearing properties have been improved; and costs reduced 50%.

STRESSPROOF makes a better part at a lower cost.

STRESSPROOF's value to manufacturers like U.S. Drill Head stems from its unique combination of four qualities in the bar: (1) Strength, (2) Wearability, (3) Machinability, and (4) Minimum Warpage. Yet STRESSPROOF costs less than other quality cold-finished steel bars. It comes in cold-drawn or ground and polished finish.

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Free Engineering Bulletin
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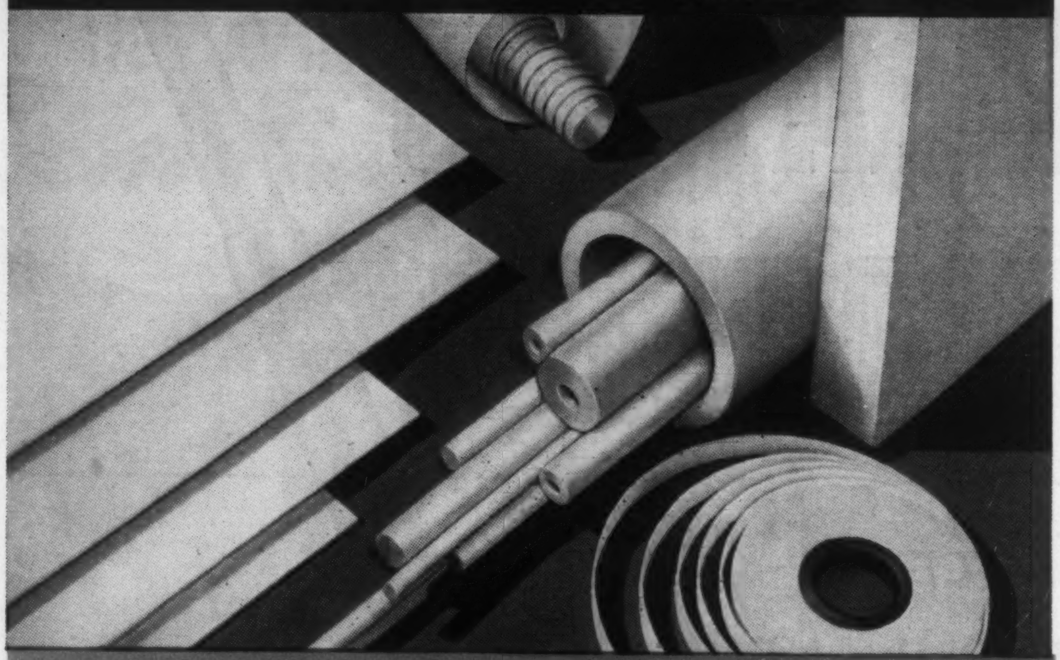

Most Complete Line of Sheets, Rods, Tape, Tubing, Bars, Cylinders, Fabricated Parts

Profit from our broad experience and completely modern specialized facilities for rapid, low-cost production of these fluorocarbon "wonder" plastics.

The finest dielectrics, especially for high frequency, high temperature electronic service. Chemically inert and non-contaminating, immune to all acids, caustics and solvents excepting molten sodium and fluorine. Tough, resilient, extremely anti-hesive—ideal for anti-friction and other mechanical uses—these "wonder" plastics open new avenues of progress to the design engineer.

Whatever your requirements, whether for stock or for custom machined or molded parts, your inquiry will receive prompt attention. Write for Bulletins No. 300 and 500.

**duPont's trademark for its tetrafluoroethylene resin.*

†Trademark M. W. Kellogg Co.

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News Digest

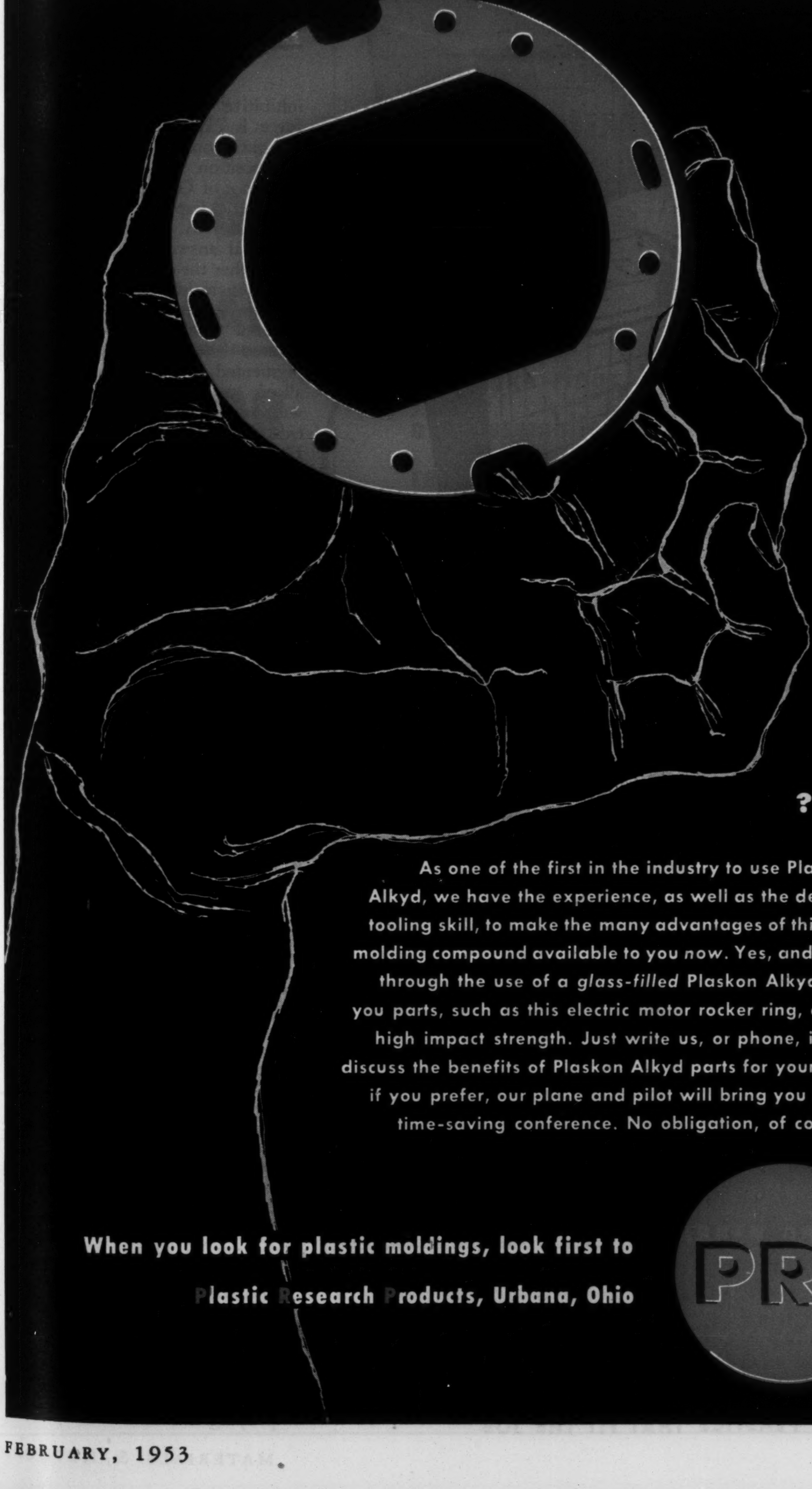
5. Safety regulations
6. Cost and availability

Consideration of fingerprint removers was a part of the conference agenda, with Lt. O. R. Cunningham of the Chemical Laboratory at Wright-Patterson Air Force Base describing how synthetic methanol is used in the present Specification MIL-C-15074A. As a part of cleaning operations and as a short term corrosion preventive, the compound he described has many applications. At Wright-Patterson Air Force Base it is being used for protection of experimental ferrous parts between times of use.

Corrosion Engineers to Discuss Protective Coatings at Chicago Conference

A number of papers of interest to engineers in product manufacturing industries will be presented at the conference of the National Association of Corrosion Engineers at the Hotel Sherman in Chicago in March.

The five papers readied for presentation during the Protective Coatings Symposium on Friday, Mar. 20, cover a variety of subjects in the coating field. "Coating Research and Applications in Atomic Energy Operations", by C. D. Watson, includes information recently declassified by the Atomic Energy Commission. The manner in which the AEC is using coatings is expected to be interesting. "Field Tests of Exterior Coatings for a Pipeline Conveying Fuel Oil Heated to 200 Deg F," by E. R. Stauffacher and B. R. Davidson, relates field tests and experience in selection of protective coatings for 41 miles of 8-in. schedule 30 pipe. Tests include application of external pressure at predetermined locations, electrical resistance measurements and cold bends. Final data and conclusions will be presented. "Filiform Corrosion" by Maurice VanLoo, presents a theoretical explanation of this type of corrosion and is illustrated with time-lapse motion photography. Filiform corrosion apparently has no direct relationship with the metallurgical pattern of the surface, light, biological activty of



As one of the first in the industry to use Plaskon Alkyd, we have the experience, as well as the design and tooling skill, to make the many advantages of this wonder molding compound available to you *now*. Yes, and now—through the use of a *glass-filled* Plaskon Alkyd—we can give you parts, such as this electric motor rocker ring, of exceptionally high impact strength. Just write us, or phone, if you wish to discuss the benefits of Plaskon Alkyd parts for your product. Or, if you prefer, our plane and pilot will bring you here for a time-saving conference. No obligation, of course.

When you look for plastic moldings, look first to
Plastic Research Products, Urbana, Ohio

PRP

A walk around your office may put your product-planning Miles Ahead
PRODUCTION ECONOMY
LUSTROUS FINISH
ELECTRICAL SAFETY
LIGHT WEIGHT
IMPACT RESISTANCE
DUREZ
PHENOLIC RESINS
MOLDING COMPOUNDS
INDUSTRIAL RESINS
PROTECTIVE COATING RESINS

● Just stroll around your desk and you'll see examples of the versatility that makes the phenolics stand out among all plastics . . . and simplifies product planning for so many manufacturers. Whatever your products may be, there's a likely place where these materials can enhance their appearance, durability, ease of use, efficiency, and economy of production.

In the form of molding materials or resins, Durez phenolics provide unusual resistance to heat, impact, abrasion, water, electrical current, and many chemicals. They offer remarkable flexibility of design. Their use often reduces assembly operations and handling and shipping costs.

The phenolics have been the special sphere of Durez operations for 32 years. We are constantly adding new compounds and industrial resins that provide new ways to make things that sell and serve better. Your custom molder and our technical staff will gladly work with your research people in suggesting . . . and working out . . . their profitable application in your business.

Our monthly "Durez Plastics News" will keep you informed on industry's uses of Durez. Write, on office letterhead.

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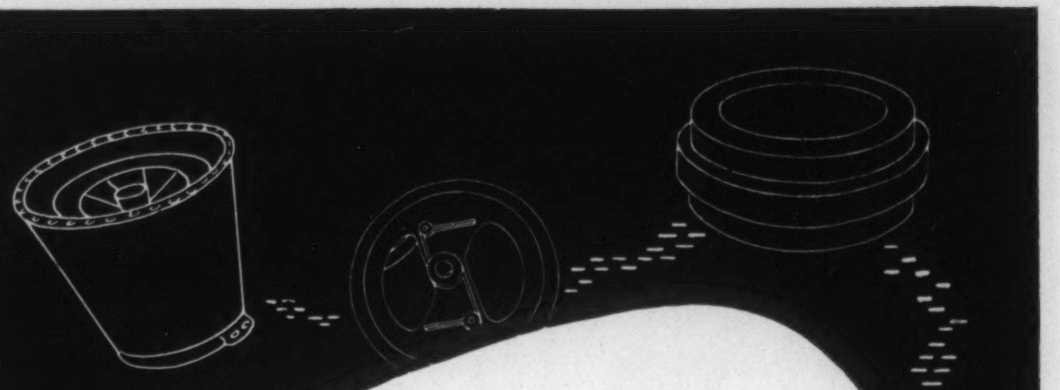
1402 Walck Road, North Tonawanda, N. Y.

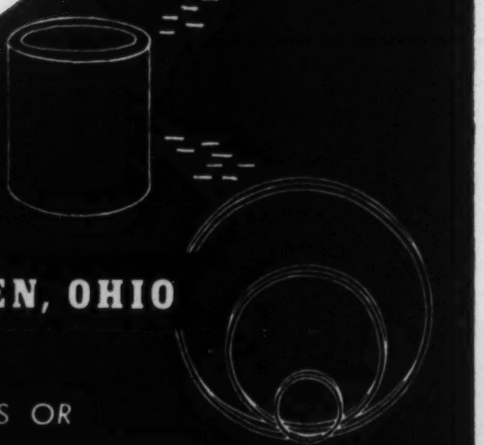
PHENOLIC PLASTICS THAT FIT THE JOB

News Digest

inhibitive pigments. The directing force is explained on the basis o. concentration cells. "Effects of the Composition of Steel on the Performance of Organic Coatings in Atmospheric Exposure", by F. L. LaQue and J. A. Boylan, gives at least a partial answer to the question as to whether the improved atmospheric corrosion resistance of alloy steels is of any advantage when they are painted. Paint was a common pigmented baking alkyd primer with pigmented baking urea modified alkyd top coat automobile finish, with and without zinc phosphate pretreatment. "Weld Seams and Weld Flux Effects on Coating Life", by A. J. Liebman, covers performance data important to corrosion engineers developed by the author.

Two sessions will be held for the presentation of eight papers in the Chemical Industry Symposium. "Effects of Structures and Phases on Corrosion of Steel", by F. A. Prange, Phillips Petroleum Co., is a discussion of corrosion problems from the metallurgist's viewpoint and includes comments on the metallurgical structure of carbon and alloy steels and their corrosion resistance. "Corrosion by Acids at High Temperatures", by R. F. Miller, R. S. Treseder and A. Wachter, Shell Development Co., deals with corrosion data for various alloys exposed to a number of acids. It also describes a method of obtaining corrosion data with acids and other media above their normal boiling points. "The Use of All-Plastic Piping and Equipment in Technical Corrosion Protection", by J. D. Huscher, Technical Director, American Agile Corp., covers a new group of self-supporting materials that are finding increasingly widespread use in corrosion resistant installations. "The Behavior of Titanium in Sulfuric and Hydrochloric Acids", by Warren W. Harple, Research Chemist, Allegheny Ludlum Steel Corp., includes new data on the corrosion resistance of titanium, including information on sulfuric acid from 0 to 95% and hydrochloric acid from 0 to 37% at several temperatures. "Graphical Multiple Correlation of Corrosion Data", by O. B. Ellis, Senior Research Engineer, Armco Steel Corp., concerns a graphical method for multiple correlation analysis of experiments having several variables. It presents a method of materially simplifying evaluation of corrosion





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data by statistical methods. "Resistance of Aluminum Alloys to Atmospheric Weathering", by R. H. Brown and associates, Aluminum Co. of America, gives results of atmospheric weathering tests of aluminum alloys. They were made under several types of atmospheric exposure conditions, including those containing industrial contaminants. "Corrosion Study in a Salt Plant", by H. O. Teeple, The International Nickel Co., Inc., and another author to be named later, will cover an extensive study of corrosion in a salt plant. The paper should be of interest to handlers of brine who are faced with salt corrosion problems. A paper by James Collins of E. I. du Pont de Nemours & Co., Inc., will include information on some of the recent developments of this company in the corrosion field.

A preliminary summary of the content of the four papers to be given during the Corrosion Principles Symposium has been given by J. V. Petrocelli, chairman of the symposium. Professor Andre J. de Bethune of Boston College will present a paper on the fundamental concepts of electrode potentials, including standard potentials. Professor Norman Hackerman of University of Texas will speak on the measurement of potentials, including reference electrodes. Dr. Morris Cohen, National Research Council, will give a paper on the interpretation and significance of potential data in corrosion. Dr. Thomas P. May, The International Nickel Co., Inc., will talk also on the significance and interpretation of potential data.

More Aluminum Predicted in Automobiles

Speaking before the Chicago section of the Society of Automotive Engineers, J. H. Dunn, assistant manager of Aluminum Co. of America's Cleveland Development Div., pointed out that aluminum is being used in greater tonnages in automobiles than ever before, and in the light of new engineering develop-

(Continued on page 181)

ments and techniques the tonnages should continue to increase.

Such items as aluminum torque converters, clutch housings, timing gears, pistons and carburetors are being installed in many car models today. Pistons, although an old time application of aluminum in automobiles, recently have been accepted by two more automobile manufacturers for production, thus putting aluminum pistons into all cars on the market today. A higher compression ratio is the chief advantage of the aluminum piston, Mr. Dunn said, in addition to light weight.

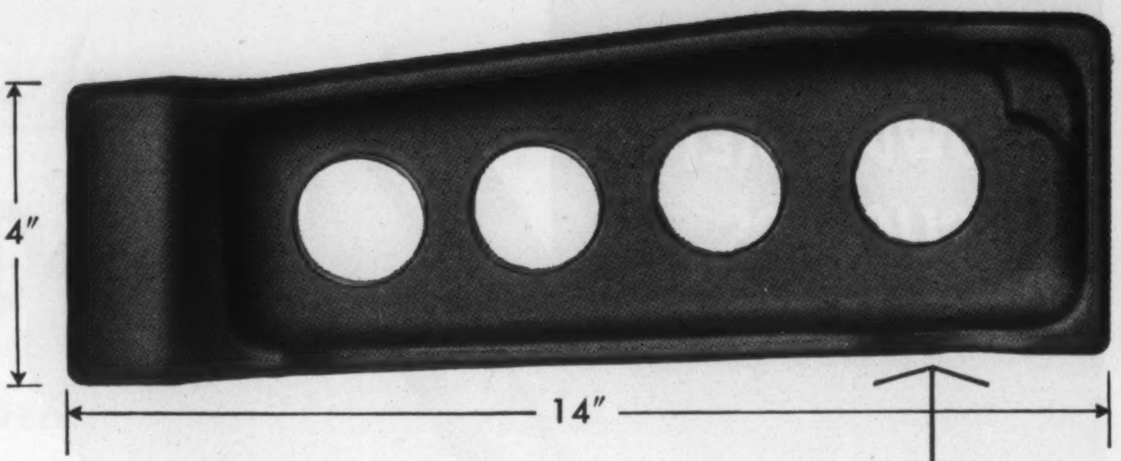
The use of aluminum in torque converters also is booming at the present time. Manifold valve covers, body trim and brakes are still other applications using greater quantities of aluminum. Aluminum is used in these parts because it is highly resistant to corrosion and dissipates heat rapidly.

According to Mr. Dunn, intensive development work is going on right now for the use of aluminum in radiators, cylinder heads and blocks. These applications are some of the hottest actual and potential applications of aluminum in automobiles because of a new brazing process. Mr. Dunn described a novel method of making aluminum cylinder heads by a sandwich type of construction, in which separately cast aluminum sections are piled on top of each other with a special brazing sheet between them. The entire assembly is then furnace brazed to produce the final one-piece cylinder head. Conventional core work is thus eliminated, with a consequent reduction in costs. The same process applies to cylinder blocks.

Rapid Rise in Output of Boron Steel

The production of alloy steel with boron as one of its alloying elements has risen rapidly this year, American Iron and Steel Institute reports.

In the first nine months of 1952 the output of this steel, at 507,358 net tons, exceeded the output in all of 1951 at 354,495 tons. As a percentage of total alloy steel other than



From Jet Bomber Parts
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Aluminum Forgings Save Weight, Save Finishing Time and Provide the Same Strength as Steel

If weight and strength are important factors in your product, then Mueller Brass Co. forged aluminum parts may be your best bet. Mueller aluminum forgings weigh only 1/3 as much as steel, yet they are approximately as strong. They make ideal parts for many applications and they are particularly desirable as parts for high speed rotating and oscillating machines because they reduce vibration and bearing loads, thus causing less wear on other parts. They possess good dimensional stability and retain their mechanical properties at high speeds and reasonable temperatures. The smooth, bright surfaces save machining time and eliminate costly finishing. Mueller Brass Co. can forge aluminum parts to your specifications in any practical size and shape from any of the standard or special alloys. Write us today for complete information.

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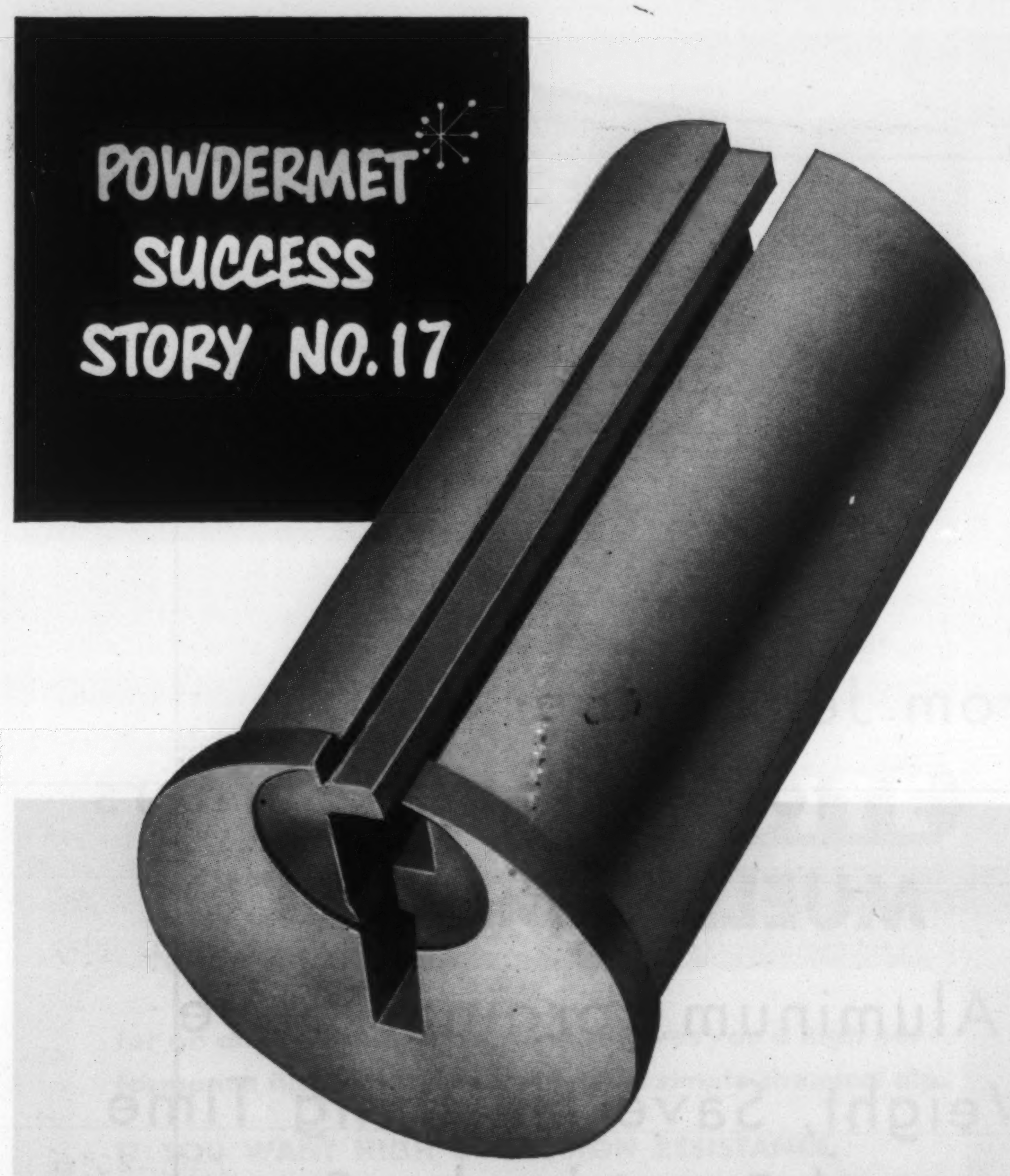

HOLDING LOCK PLUG TOLERANCES TO ±.0005"!

Formerly the manufacturer had to broach these small lock plugs in order to hold a tolerance of plus or minus .0005". Naturally the machining operation was costly and time-consuming. It was obviously desirable to use powdered metal but because of the extremely close tolerances it was considered unworkable.

Then they came to Powdered Metal Products Corporation of America and discovered PMP could supply plugs to the required tolerances and still substantially lower the cost. There was no sacrifice of quality or wear characteristics. In fact the PMP plug withstands repeated tests of over 500,000 cycles—much more than encountered in normal use.

If you have a problem involving production parts, why not consult Powdered Metal Products? Their complete facilities assure finest results.

Write today for complete information.

sign of leadership PMP* in powder metallurgy

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News Digest

stainless, it jumped to 9.2% in nine months of this year from 4% in all of 1951. Prior to 1951 very little boron was used in steel, its broader introduction after the beginning of war in Korea being for the purpose of conserving critical alloy materials.

The use of only 8 lb of boron in a 150-ton heat of alloy steel saves a total of 4,800 lb of nickel, chromium and molybdenum—alloy materials that are in stringent supply in proportion to increased demand.

Battelle Installs Cobalt 60 Radiation Source

The most powerful and most generally useful radioactive material so far made available for industrial research, Cobalt-60, has gone to work at Battelle Memorial Institute, where it is expected to be used to develop improved methods for chemical processing, inspection of metals and other materials, and the sterilization of foods and medicines.

Institute scientists and engineers designed a massive 5-ton structure of lead and concrete to safely shield 100 curies of the high-energy source. This amount, equivalent in radioactivity to $2 million worth of radium, weights around 1½ oz and is about the size of the outer half of the thumb. The radiations given off by cobalt-60 are about equal in penetrating power to those of a 2,000,000-electron-volt x-ray machine, according to Battelle radiochemist Ralph Belcher.

"This tremendous energy", Belcher says, "will give us a powerful new tool for conducting studies extremely difficult or impractical before, because of the lengthy periods of radiation necessary with other available radioactive materials.

"The new facility will enable us to set up research projects on a pilot-plant scale. This research with cobalt-60 will lay the groundwork for future work with other equally effective atomic energy by-products that will become available at some future date."

Cobalt-60 will be particularly useful in the detection of internal flaws in metals and other materials, where the more expensive million-volt x-ray

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Your past favors have been appreciated and we are looking forward with pleasure to working with you in a prosperous future.

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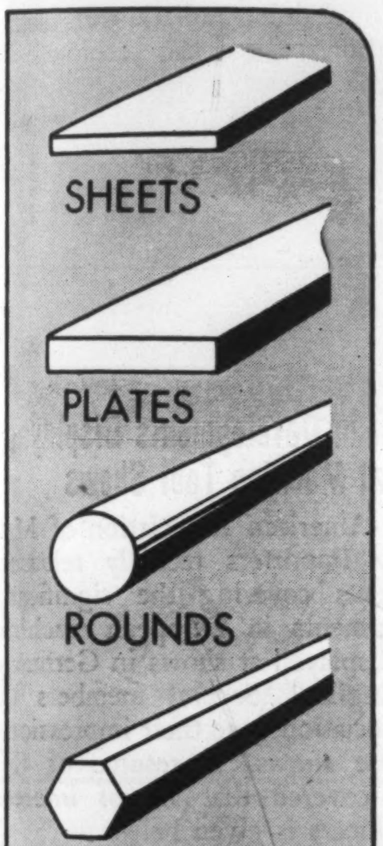
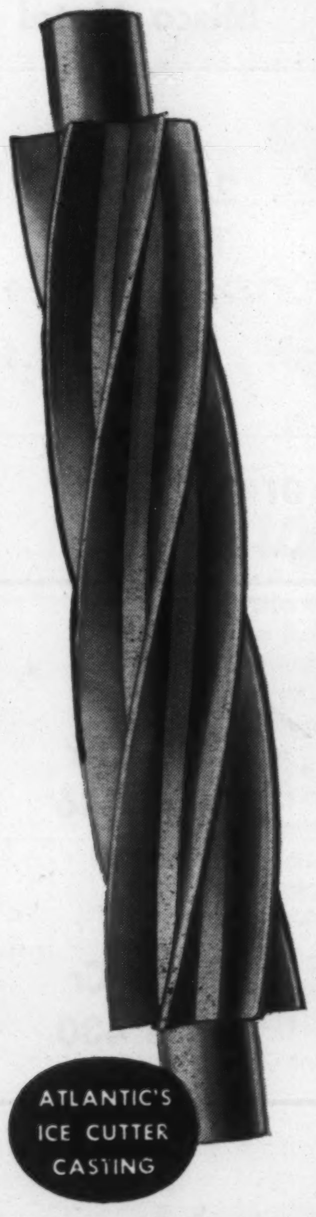


COLD FACTS

about YORK'S new ICE CUTTER

YORK FLAK-ICE AUTOMATIC ICE MAKER, MODEL DER-2
ICE HARVESTING SYSTEM



AN IMPORTANT COMPONENT of York Corporation's most recent development, the York-FlakIce Automatic Ice Maker, is Atlantic's ice cutter casting. It cuts the ice into curved flakes... so delicate they will not damage or puncture delicate rose petals.

YORK'S ORIGINAL CONCEPTION of the ice cutter... a vital part of the ice harvesting system ...consisted of three stainless steel parts which had not only to be machined, but welded together.

ATLANTIC'S ENGINEERS suggested a design that eliminated these costly operations and increased the productive efficiency of the ice cutter. Six spiral blades on a center shaft were all plaster mold cast in *one piece* of Atlantalloy #31 High Tensile Manganese Bronze... an alloy of great endurance and strength.

York will testify that Atlantic's all-in-one-piece ice cutter casting surpassed all requirements for high physical values, closely-held tolerances, satin-smooth finish, fine-grained structure, clean-cut surfaces... and afforded them substantial savings over former costs.

Find out how the Atlantalloy plaster mold casting process can help solve some of your problems' Write for a free copy of "High Quality Precision Castings for Industry" today!

HIGH QUALITY PRECISION CASTINGS for industry

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machine might otherwise be necessary, it was said.

"Cobalt-60 will be used to induce chemical reactions in chemical processing. In the making of some plastics, for example, it will replace chemical catalysts that may introduce undesirable impurities in the plastic material. The new high-energy source will also be more effective and less cumbersome than ultra-violet radiation in some applications where this technique is employed."

European Developments Displayed at Machine Tool Shows

The American Association of Machinery Importers recently released statements covering the significant developments in European machine tools displayed at shows in Germany and England. Several members of the association gave their impressions of these shows. A resume of the points covered that are of interest to engineers is given below.

Hanover Exhibition

The objects of the Hanover (Germany Fair were stated as follows: (1) to reduce the noncutting time of machines, since modern tools both in Europe and America are nearly all capable of handling material at its full workability; (2) to make the design of machines more universal to take on a wider range of jobs—Europeans frankly admit they leave the assembly line production machines to the United States, which knows how to build them and actually has uses for them; (3) infinite and sensitive variations of speeds and feeds through electromagnetic couplings and pre-selectors —this objective was well accomplished and found on a multitude of machines from all countries; and (4) semi-automatic and automatic copying by many ingenious methods—the fad of copying has taken hold in Europe as well as in the United States, and some patents date back more than 100 years.

In the past, European machinery in general was somewhat under-

This continuous roll machine at the C-D-F, Bridgeport, Pa. plant makes top quality sheet fibre for electrical insulation. Corrosion-resistant rollers are made from laminated Dilecto, another famous C-D-F product.

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VULCANIZED
FIBRE

- mechanically and electrically strong
- moisture, arc and chemical resistant
- high dielectric strength
- easily machined and formed
- low-cost with long life

watched all the way...

DIAMOND VULCANIZED FIBRE

Naturally it takes a big, well-equipped company like C-D-F to make fibre. It also requires a special brand of know-how and long experience to take rag paper (we make our own), zinc chloride and water and come up with a low-cost uniform product that can be adapted to a million uses.

Maybe you think that vulcanized fibre has been replaced by many newer, more publicized materials. Actually Diamond Vulcanized Fibre today has more applications, more unique qualities, more product design value than ever before.

If you need a dependable source for bone, commercial, Diamond "fish paper" insulation, tubes, rods, receptacles . . . talk to the man who knows . . . your C-D-F sales engineer (offices in all principal cities), or write C-D-F, Newark, Delaware.

THE NAME TO REMEMBER CDF DIAMOND VULCANIZED FIBRE

Continental-Diamond Fibre Company

NEWARK 25, DELAWARE

AMERICAN CHEMICAL PAINT COMPANY

AMBLER CHEMICALS ACP PROCESSES PENNA.

Technical Service Data Sheet

Subject: HOW GRANODRAW PHOSPHATE COATING FACILITATES COLD EXTRUSION OF STEEL

INTRODUCTION

By phosphate coating steel, prior to cold working it, extrusion, drawing, and other forming operations are greatly improved. In fact, it is the protective zinc phosphate coating that makes for the successful cold deformation of steel.

The tremendous pressures that most forming operations require produce extremely high frictional contact between die and metal. Without a protective coating, excessive galling (welding) of dies, breakage of tools, and unduly short die life will result. The combination of a non-metallic crystalline phosphate coating with an adsorbed lubricating film, possesses a low coefficient of friction while maintaining its stability under extremely high deforming pressures. This combination, therefore, greatly minimizes the aforementioned tool difficulties.

THE COLD EXTRUSION OF GENERATOR FRAMES

Cold extrusion is now being used advantageously in the manufacture of high production generator frames. This operation is facilitated by careful preparation and proper coating of the frame blank which is made from SAE 1010 open hearth plate steel.

After wheelabrating to remove the scale, the blank is rolled up and then fed automatically through a six stage dip wheel type washing machine which cleans the surface and applies the coating. The frame is then fed into an extrusion press where the wall thickness is increased on one end and reduced 47.5 percent on the other end. This operation produces concentric frames of uniform thickness and correct dimensions.

The Granodraw coating produces the proper surface to receive the lubricant by furnishing an extremely adherent film with the proper crystal size and continuity of coating required to insure maximum adsorbsion and tenacity by the lubricant. The lubricant, Montgomery DF 1101, is a combination of titre alkali soaps and resins. It is a powder which when dissolved in water and redeposited on the phosphate coated work piece, produces the necessary surface for subsequent operations. This film is dry and considerably less hydroscopic than similar coatings of the soap type. The concentrations of both the Granodraw and DF 1101 are maintained by simple chemical analysis.

PROTECTIVE COATING SEQUENCE

Stage	Operation	Chemical	Time	Temperature
1	Load and unload			
2	Cleaning	Tri-sodium phosphate and soda ash	1 Min.	180° F
3	Water rinse		1 Min.	180° F
4	Zinc phosphate coating	"Granodraw"*	4½ Min.	165° F to 180° F
5	Water rinse		2 Min.	180° F
6	Lubricating	H.A. Montgomery lubricant DF 1101	4½ Min.	190° F

*Trade Mark of the American Chemical Paint Company

CHEMICALS ACP PROCESSES

News Digest

powered for American use. This has been realized by the German manufacturers, and what used to be 5 or 10 hp is now 7 and 12 hp. The change from 50-cycle European specification to American 60-cycle is no longer done by means of getting a larger motor and deducting 10% of its output. Now they actually wind to 60 cycles. This brings the power application to a better, more dependable standard.

An outstanding feature of a few German machines at the fair was the greater simplification, not only of location, but of the controls themselves, mostly done electronically. This should be an important point of attraction to the American worker, as it eliminates work. It also gives greater assurance to the manufacturer, since it will avoid errors and reduce time.

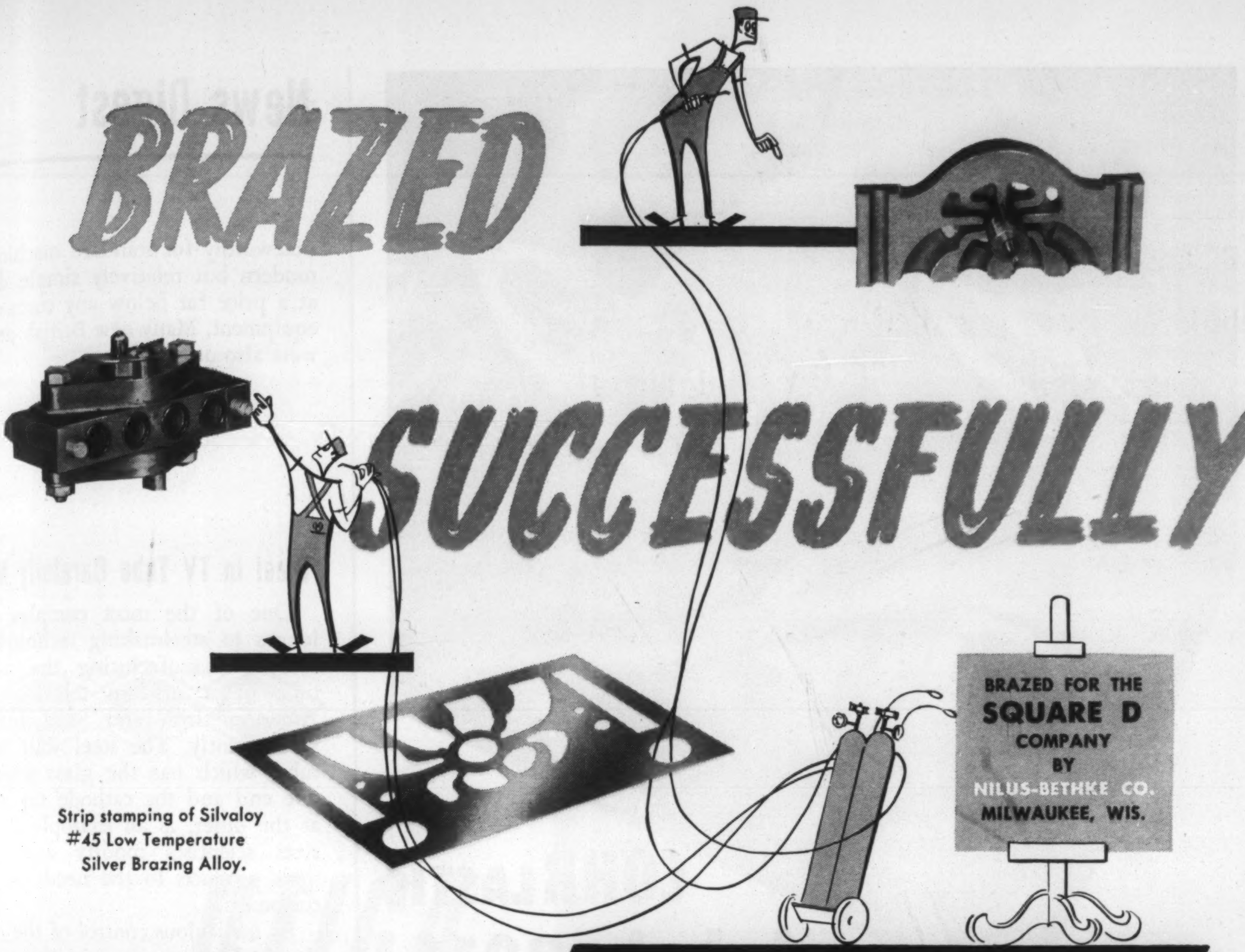
At Hanover, of course, the greatest majority of machine tools shown were of German make. However, the Italians showed some very fine machines and some of them of impressive dimensions.

Olympia Exhibition

In comparing the Olympia, England, show with past ones, some developments were noteworthy. Widespread use was made of electronic control devices, and almost universal use of copying attachments. Developments on new copying lathes and copying milling machines were also noted. Increased rigidity, higher spindle speeds and wide use of antifriction bearings on most machines made for better utilization of carbide tooling, which has resulted in the manufacture of new carbide grinding machinery and profile grinders for use in grinding carbide cutters. Much in evidence was an entirely new type of specialized machine tool for the manufacturing of jet engine components, and especially jet blades. Also noteworthy on the manufacturing side was increased use of flame hardened ways and the switch from scraping to slideway grinding and even slideway milling.

The equipment of each country was outstanding for particular reasons. American machines that stood out were for high production work and for manufacturing jet engine components. Swiss exhibits were marked by their extremely accurate and superbly finished jig borers and measuring machines. Britain was

BRAZED SUCCESSFULLY WITH . . .



Strip stamping of Silvaloy #45 Low Temperature Silver Brazing Alloy.

SILVALOY

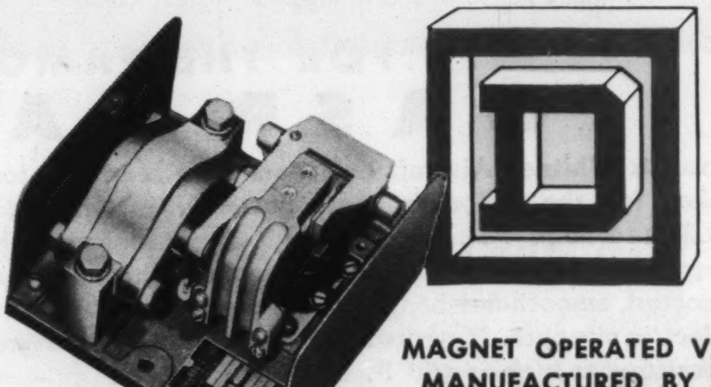
LOW TEMPERATURE SILVER BRAZING ALLOY

The Magnet Operated Valve manufactured by the Square D Company is an outstanding example of engineering and manufacture. Metal of the precision cast valve body halves, selected for best operating results, is manganese-aluminum bronze . . . a difficult material to braze.

To braze manganese-aluminum bronze on a production basis is a complicated problem. When production brazing must meet Square D standards, it takes the best skill, silver brazing alloy and flux to do the job.

It is being done—successfully—by Nilus-Bethke Co., using Silvaloy #45 Silver Brazing Alloy in strip stampings and APW Aluminum-bronze Flux.

For the best low temperature silver brazing alloys, call the Silvaloy Distributor in your area. They'll also be glad to send Silvaloy Technicians to assist in developing lowest cost —highest production in your brazing department. ★ ★



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APW

COHRLASTIC
fabric 3016
gaskets
FOR THE FAMOUS
WASP MAJOR

When Pratt & Whitney Aircraft engineers were searching for a superior rocker-box gasket for the *"World's most powerful piston engine,"* they selected COHRLASTIC 3016 . . . a new "wonder" material made by a special process of impregnating glass fiber with silicone rubber. This unique rubber-like sheeting is level-coated, smooth-finished, soft and resilient with low compression set and high dielectric strength. It withstands oxidation and exposure to lubricating oils at temperatures as high as 450°F.

At −70°F gaskets of natural rubber and most synthetics freeze and shatter; around +200°F they oxidize, soften, disintegrate. COHRLASTIC gaskets stand arctic temperatures down to 100 below and engine heats up to 500 above, hot oil, vapors and other rugged service conditions of flying at higher altitudes, faster speeds, longer distances. These gaskets can be counted on to last the full 800 to 1000 hours before engine overhaul.

COHRLASTIC 3016 is a heat resistant material consisting of glass fabric coated with white silicone rubber.

DESIGNED for operating temperatures ranging from −100°F to +500°F.

RESISTANT to mild alkalies, mild non-oxidizing acids, most salts, mineral oils, oxygenated solvents, air and water.

STRENGTH TESTS: Bursting 378 lb psi; breaking, cross 200 lb pi; length 250 lb pi.

STOCKED in rolls 36" wide; thickness 0.016"; weight 19 oz. psyd.

AVAILABLE by the yard for fire curtains, ducting, conveyor belts, or to order as finished die-cut gaskets ready to use.

Write for swatches and date sheets

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NEW HAVEN, CONNECTICUT

PRODUCT OF THE
Connecticut

noteworthy for standard machines of modern but relatively simple design at a price far below any competitive equipment. Many new British designs were also unveiled.

Steel in TV Tube Carefully Made

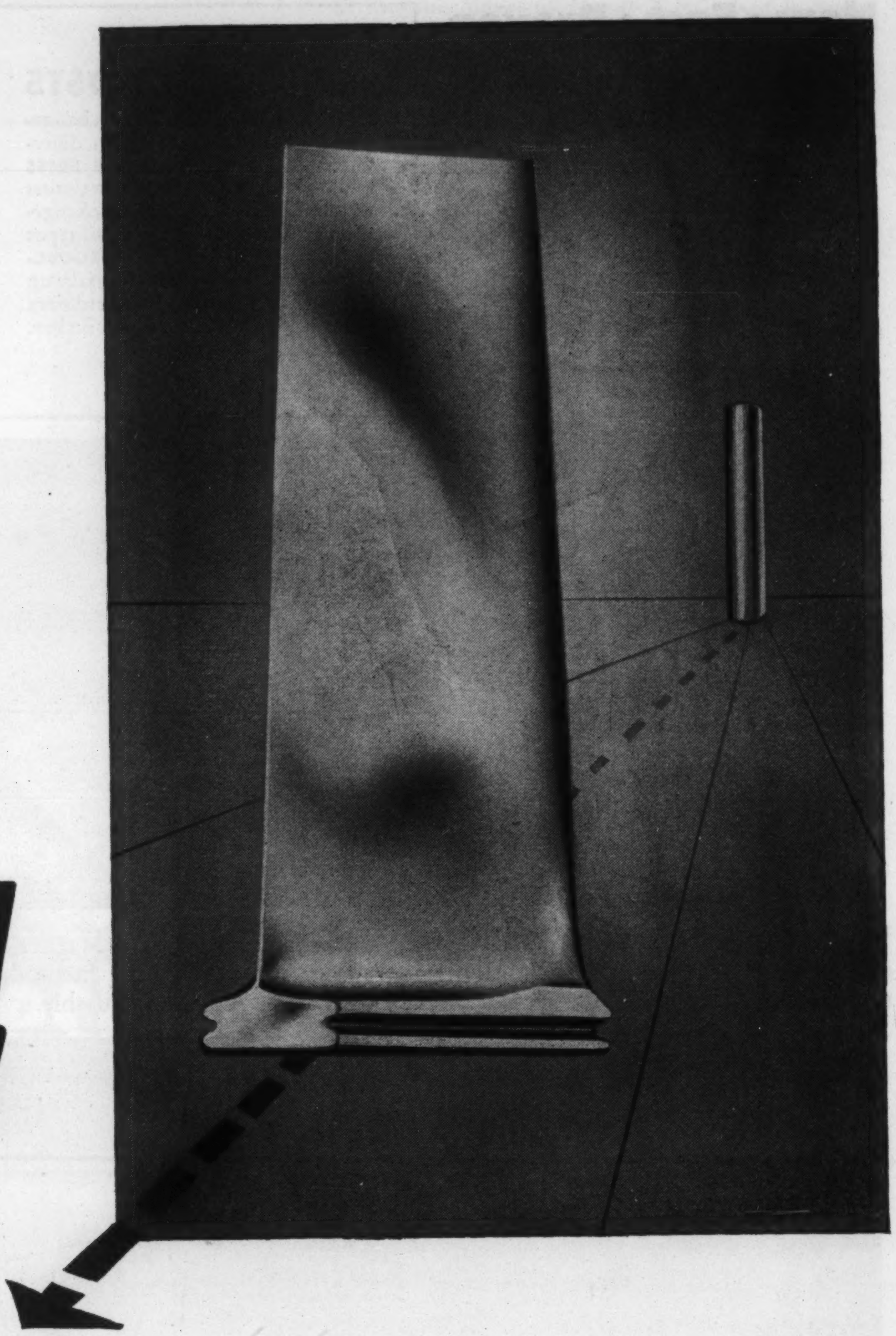
One of the most complex challenges to steelmaking techniques is met in manufacturing the picture tube of a modern television set, American Iron and Steel Institute said recently. The steel wall of the tube, which has the glass screen at one end and the cathode ray source at the other, is an example of how steel scientists modify and adapt their products to the needs of their customers.

By meticulous control of the steel's chemical composition in the electric furnace, metallurgists have developed stainless and alloy steels that expand and contract at almost the same rate as glass. When the coated glass that forms the picture screen of a television tube is bonded, by heat, to the steel walls of the tube, both glass and steel expand at nearly the same rate. The materials also cool at a similar rate after they are sealed together into an airtight vacuum tube. The glass would break if the expansion or contraction rates of the steel and glass differed significantly.

The use of steel walls for television tubes permits more rapid fabrication than if the whole assembly were made of glass, as originally designed. The total weight of the tube is reduced and its strength increased.

Metal Powder Show and Meeting Scheduled for Cleveland

The Metal Powder Association's Ninth Annual Meeting will take place on Apr. 20, 21 and 22, 1953, at the Hotel Cleveland, Cleveland, Ohio. Carrying through the meeting's theme, "Progress in Powder Metal-



UTICA HELPS

BY SPEEDING STEPS BETWEEN BAR STOCK AND BLADE

Every military supplier has a *special* war to win. He must win his own race against his enemy counterpart.

As primary suppliers of forged turbine and compressor blades to the aircraft industry, UTICA is going at top speed. But that *alone* is not good enough — not for *this* race.

So we at UTICA examine our methods, study them, modify them, improve them. We seek always to speed, shorten and eliminate steps between bar stock and blade.

The job must be done today, for today is soon tomorrow. Tomorrow's method will not wait until the day after — not at UTICA.

U TI CA ®

UTICA DROP FORGE & TOOL CORPORATION, Utica 4, New York

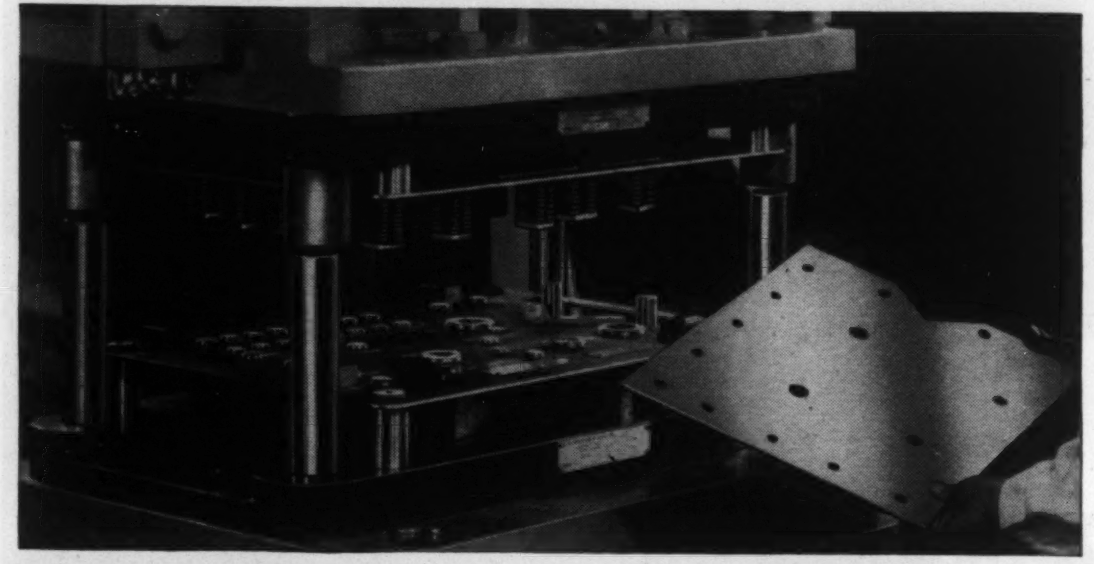
MAKERS OF THE FAMOUS UTICA LINE OF DROP FORGED PLIERS AND ADJUSTABLE WRENCHES

New • Fast • Proven

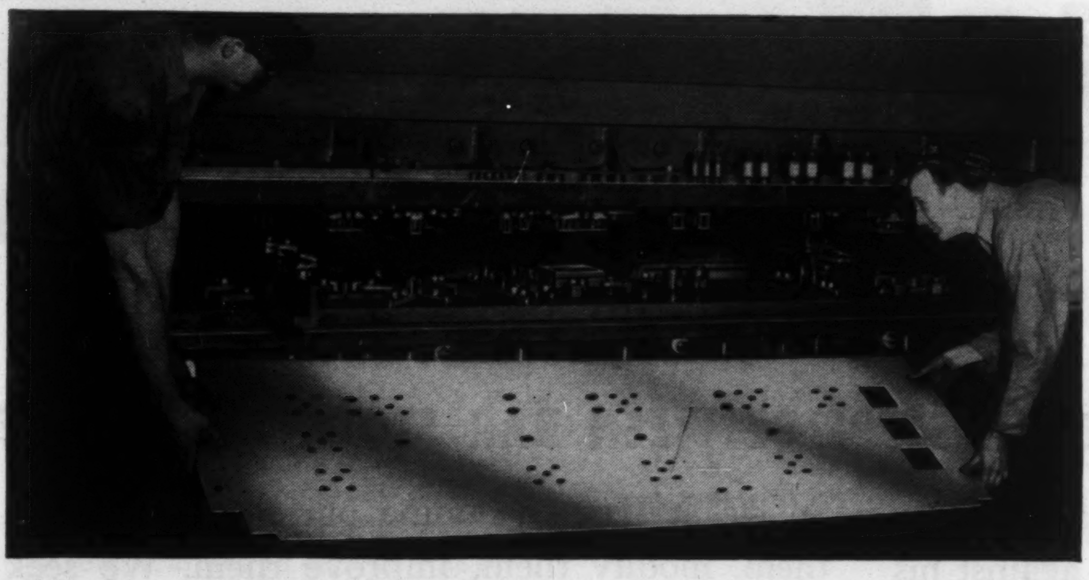
LOW COST methods for PERFORATING and NOTCHING SHEET METALS

REDUCE DIE COSTS

All units and parts are interchangeable and used repeatedly in different arrangements. **INCREASE PRESS PRODUCTION**—*Down time is minutes as compared to hours for changeover.* For precision work in all types and sizes of presses. **START PRODUCTION AT ONCE.** Pierce materials up to ¼″ thick mild steel. Standard sizes and shapes available up to 3 inches. Special sizes to order.



Whistler *MAGNETIC* Dies at work in large inclinable press. Magnetized retainers hold the units. No bolting required. A fast, economical method in making up a punch and die set for short or long runs. All parts re-usable.



Whistler *ADJUSTABLE* Dies on perforating and notching job, using Tee slotted die set. With Whistler Adjustable Punch and Die units production starts within hours instead of weeks. Last minute job changes made quickly.

WHISTLER MAGNETIC PERFORATING DIES
WHISTLER ADJUSTABLE PERFORATING DIES

● Here are the complete details with prices and application illustrations. Send for these catalogs. No obligation.

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S. B. WHISTLER & SONS, Inc.
Adjustable, Magnetic, Custom and Cam Dies for all Industry
756 Military Road, Buffalo 23, N. Y.

News Digest

lurgy," subjects tentatively scheduled for presentation include:

1. The application of metallic friction materials in heavy duty transmissions such as tanks, airplanes and other military as well as civilian uses.
2. Flame plating, both as a new use for metal powders as well as a technique for improving the production of sinterings.
3. Progress in this country in the development and application of SAP (sintered aluminum powder).
4. Use of iron powder and other metal powder sinterings in business machines.
5. Powder metallurgy of refractory metal powders for special high temperature applications.
6. New developments in brass powders.
7. Survey review of where powder metallurgy stands today.

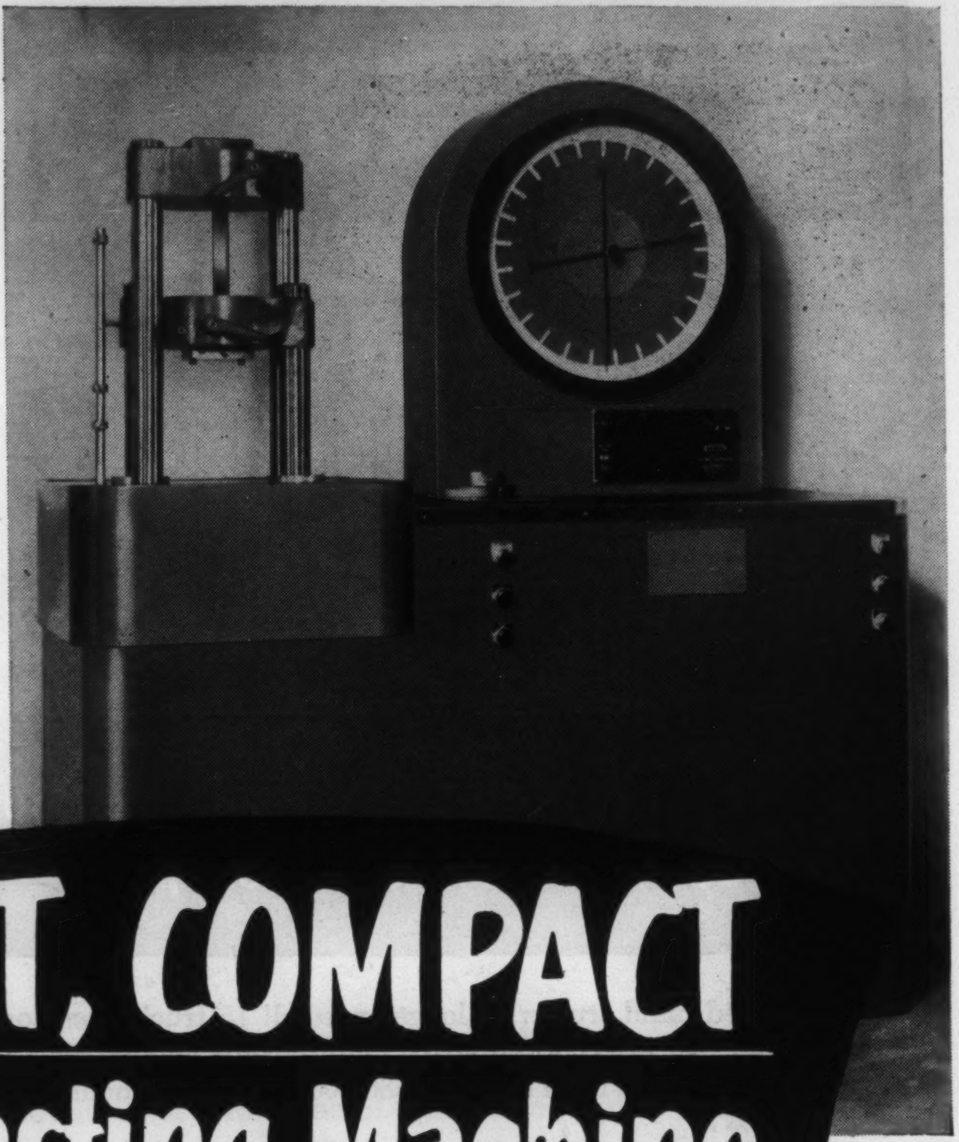
Paralleling the formal program at its Ninth Annual Meeting, the Metal Powder Association will sponsor the Metal Powder Show. Consisting of exhibits by leading sinterings fabricators, powder producers and equipment manufacturers, the Show will enable visitors to see the progress in powder metallurgy on display.

NACA Publishes Research Reports

A number of reports on research of interest to materials engineers have been published recently by the National Advisory Committee for Aeronautics. The reports are available from the NACA, 1724 F St., N. W., Washington 25, D. C. Abstracts of these reports are given below:

"Investigation of Wear and Friction Properties Under Sliding Conditions of Some Materials Suitable for Gages of Rolling-Contact Bearings." Robert L. Johnson, Max A. Swikert and Edmond E. Bisson. (NACA Rept. 1062. Formerly TN 2384). The wear and the friction of brass, bronze, beryllium copper, monel, Nichrome V, 24S-T aluminum, nodular iron, and gray cast iron

Universal Testing Machine Model 60-H with T.E.G. load indicator



Now Baldwin Testing Headquarters Meets Your Needs With This New

LOW COST, COMPACT Universal Testing Machine

Recognizing your need for a low cost, faster and compact Universal Testing Machine, Baldwin-Lima-Hamilton Testing Headquarters developed Models 60-H and 12-H.

Quantity production makes possible fast deliveries and lower cost; nevertheless, the quality is so fine that its use in research laboratories is justified, particularly when equipped with the new T. E. G. load indicator.

With one of these new machines you would gain all of these advantages: (1) The first low cost machine which exceeds all minimum requirements for the routine testing job. (2) Faster, more rugged, more foolproof and able to stand more abuse than any comparable machine. (3) Operational damage prevented by simple safety devices. (4) One unit design with two unit features . . . will fit area only 67½" by 27"! Indicator housing supported independently to eliminate transmission of recoil. (5) Adjusting screws are completely enclosed in base and lubricated for life, eliminating worry and care. (6) Practically noiseless operation. Single knob control for loading and return.

For full information about the specifications and capabilities of this machine, write for our new Bulletin 4204 to: Dept. 2123, Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

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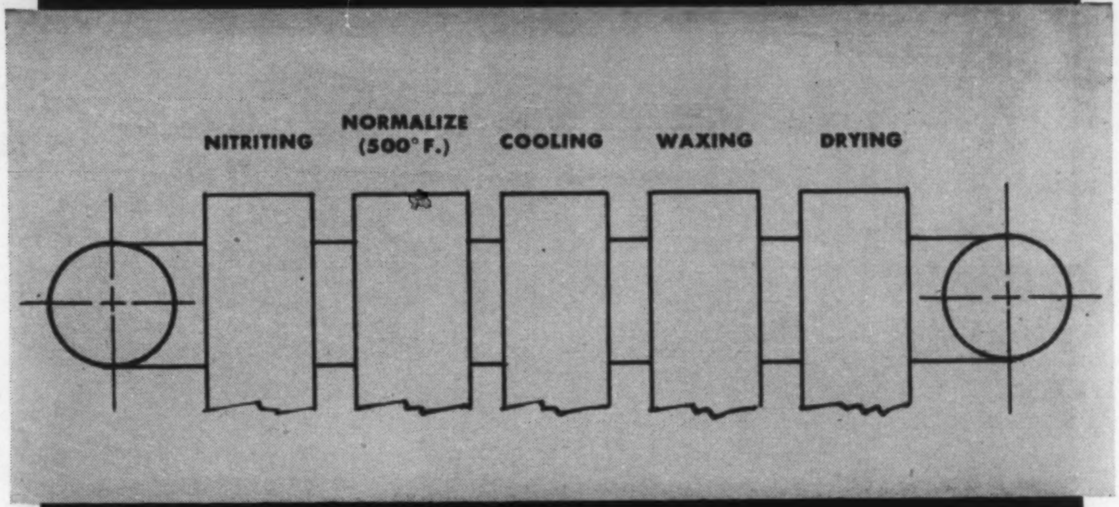
CAMBRIDGE WIRE MESH BELTS . . .



help spring producer boost output 350% in 30% less floor space!

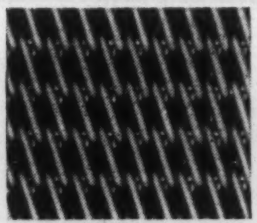
110 old-fashioned hand trucks no longer needed! 15 truck operators freed for more productive work! Floor space requirements cut by 30%. Output rose from 290,000 pieces in 24 hours to 680,000 pieces in 16 hours, *an hourly increase of 350%!*

These were the results of this installation of a 98′ Cambridge wire mesh belt in a large spring producing plant. The moving belt gives continuous production, eliminates the need for hand trucks in transferring the work from one step to the next, assures uniformly processed work.

Perhaps Cambridge wire mesh belts can help you get similar savings. They're available in any metal or alloy, mesh or weave, length or width. They can be used under practically any conditions . . . from temperatures as high as 2100° F. down to sub-zero, for handling work through simple water rinses or highly corrosive acid sprays, for carrying small delicate parts or heavy, bulky loads. All-metal belt construction assures long life and freedom from damage. Open mesh permits free drainage of process solutions or free circulation of process atmospheres.

WHY NOT CALL IN YOUR CAMBRIDGE FIELD ENGINEER?

You can rely on his experienced advice to recommend just the right type of wire mesh belt for your process. Look under "Belting-Mechanical" in your classified phone book for the Cambridge office nearest you.



Cambridge Duplex Weave, one of the most widely used specifications for continuous heat treating.

FREE BELT MANUAL tells how Cambridge belts can be used in your industry. Also includes useful data on conveyor design, metallurgical tables and belt specifications. Write for your copy today.

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SPECIAL METAL FABRICATIONS

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News Digest

sliding against hardened SAE 52100 steel were studied.

"An Engineering Method for Estimating Notch-Size Effect in Fatigue Tests on Steel." Paul Kuhn and Herbert F. Hardrath. (NACA TN 2805). Neuber's proposed method of calculating a practical factor of stress concentration for parts containing notches of arbitrary size depends on the knowledge of a "new material constant" which can be established only indirectly. In this paper, the new constant has been evaluated for a large variety of steels from fatigue tests reported in the literature, attention being confined to stresses near the endurance limit; reasonably satisfactory results were obtained with the assumption that the constant depends only on the tensile strength of the steel. Even in cases where the notches were cracks of which only the depth was known, reasonably satisfactory agreement was found between calculated and experimental factors. It is also shown that the material constant can be used in an empirical formula to estimate the size effect on unnotched specimens tested in bending fatigue.

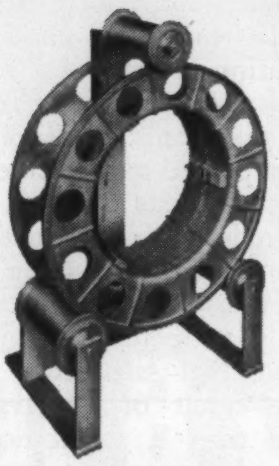
"Effects of Cyclic Loading on Mechanical Behavior of 24S-T4 and 75S-T6 Aluminum Alloys and SAE 4130 Steel." C. W. MacGregor and N. Grossman. Massachusetts Institute of Technology. (NACA TN 2812). An investigation was conducted to determine the effects of cyclic loading on the mechanical behavior of 24S-T4 and 75S-T6 aluminum alloys and SAE 4130 steel. Specimens of the three materials were subjected to various numbers of prior fatigue cycles both below and above the fatigue limits. Special slow-bend tests were employed to show the effects of prior cycles of fatigue stressing on the transition temperature to brittle fracture for SAE 4130 steel and on the energy-absorption capacity of the aluminum alloys. Micrographic studies were made to observe and measure crack formation and propagation and additional special tests were conducted to supplement the results of the slow-bend tests. These included Charpy impact tests, microhardness surveys, tension tests, and fretting-corrosion studies.

"Effects of Solvents in Improving Boundary Lubrication of Steel by Silicones." S. F. Murray and Robert L. Johnson. (NACA TN 2788).

NOW

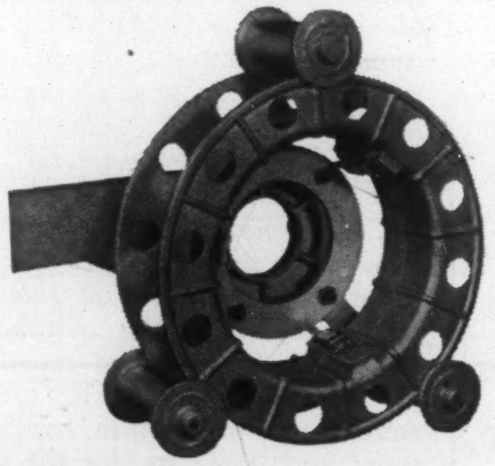
Double and Triple weight coils for automatic welding with the new REID-AVERY (free wheeling) REELS for Submerged Arc, Open Arc, and Gas Shielded Arc Welding

Decrease down-time by using larger coils. Machines now equipped for 25 lb. coils can use up to 75 lb. coils with these new reels.



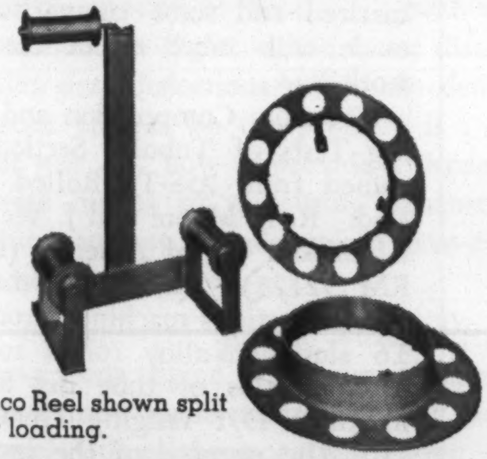
Raco Reel for 150-200# coils with floor mounting stand.

These cast aluminum alloy reels ride on ball-bearing trunnions with deep flanges. The wire uncoils with remarkable ease and yet there is no chance of overrunning and throwing loops over the side. No brakes or drags of any kind are necessary. The wire itself prevents overrun. These "free wheeling" reels provide the absolute minimum load on the automatic welding machine.



Raco Reel for 25#-50#-75# coils. Mounted on popular submerged arc machine.

The Reid-Avery reels are available with stands for floor mounting or with special spiders for direct attachment to most popular automatic welding machines. Three reels 12" ID x 4" wide, 14" ID x 6" wide, and 25" ID x 4" wide nominal size are in stock for prompt delivery.



Raco Reel shown split for loading.

Note the simple split reel construction with suitcase type latches. Coils can be replaced in seconds and no wrenches or special tools are required.

We are equipped to supply all sizes of layer wound coils for these reels, for other reels, or on expendable wooden spools where required.

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SINCE 1919 PRODUCERS OF ARC WELDING ELECTRODES AND WELDING RODS

Dickson pens the temperature-

with
CHACE BIMETAL

Product of
Dickson Company
Chicago 19, Illinois

THE Dickson multi-range Minicorder Type 1A is designed to draw a continuous chart record of the exact surrounding temperatures. With this multi-range recorder, extremely accurate recordings can be made of the temperatures in deepfreeze compartments, standard refrigerators, general air conditioning and other temperature controlled areas. The compact Minicorder measuring element is a specially designed spiral coil of Chace Thermostatic Bimetal calibrated to move a pen across the chart with a temperature change of 45°.

The precision-wound coil is fixed to the outer end of the mounting on the back of the dial. A pen with an extended arm is attached to a shaft that is spot welded to the inner end of the coil. Changes in room temperature cause the element to react in a coiling or uncoiling motion, thus causing the pen to move left or right, recording the temperature. At the same time a spring wound clock rotates the chart to synchronize the time with the temperature reading.

The accuracy of this multi-range recorder is dependent upon precision manufacturing and assembly methods. We fabricate this type of coil from precision-rolled strip stock in a controlled-temperature department. We also provide our 29 types of thermostatic bimetal in elements to customer design, in strips, random coiled lengths or welded or brazed sub-assemblies. Before proceeding with your next design, consult our Application Engineers or write for our 32-page booklet, "Successful Applications of Chace Thermostatic Bimetal," containing condensed engineering data.

IT BENDS WITH THE HEAT

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Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

News Digest

Because the known synthetic fluids best satisfy the viscometric requirements for lubricants for turbine engines, a study was conducted to establish the effect of solvents on boundary lubrication by silicones. Boundary-lubrication data was obtained which are considered substantiating evidence for a hypothesis that, is solutions of solvents blended with silicones, the silicones form a closely packed and oriented absorbed film on ferrous surfaces. The solutions reduced friction and prevented surface failure even when the solvent as well as the silicone was an extremely poor lubricant. These data indicate that satisfactory lubrication is the result of a solvation effect rather than a lubrication additive effect of the solvent because 30 to 50% of solvent was necessary for good results. The best results were obtained with solvents having dipole moments. Solutions of diesters in silicones may be practical lubricants.

"Torsion Tests of Aluminum-Alloy Stiffened Circular Cylinders." J. W. Clark and R. L. Moore, Aluminum Co. of America. (NACA TN 2821). Results are presented for the second series of torsion tests on aluminum-alloy stiffened circular cylinders, the first series having been reported in NACA ARR 4E31. The cylinders were similar in 0.020 in. for the first series and 0.032 in. for the second series. The significant observation from both series of tests are summarized and some comparisons are made with more recent theoretical work.

"Torsion, Compression and Bending Tests of Tubular Sections Machined from 75S-T6 Rolled Round Rod." R. L. Moore and J. W. Clark, Aluminum Co. of America (NACA RM 52125). Tests were made of tubular sections machined from 75S-T6 aluminum-alloy rolled rod and having ratios of tube dia to wall thickness D/t ranging from 2 to 150. The purpose of the investigation was to establish curves of strength in torsion, compression and bending against D/t for the tubular sections and to show to what extent these strengths may be correlated with the mechanical properties of the material. In view of the acceptable mechanical properties obtained for the material, the relations obtained between these strengths and D/t may be used as a tentative basis for design of members of the type investigated.

How Hot can a Jet Get?

Whooosshh! Jet engines generate a powerful amount of heat . . . heat which, uncontrolled in flight, would cause disastrous metallurgical distortions within the delicately balanced engine. So the problem is . . . or rather *was* . . . how to provide a dependably accurate means of measuring exhaust temperatures so that the pilot might have control over how hot his jets get.

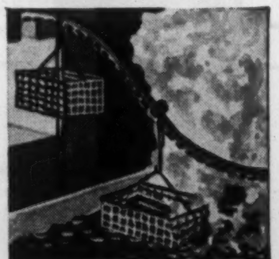
And the answer? Special wiring harnesses running from engine to instrument panel . . . harnesses now made exclusively with Hoskins Chromel-Alumel thermocouple alloys.

Yes, wherever durability and accuracy are required in a thermocouple . . . whether for jet engines or industrial furnaces . . . you'll find Chromel-Alumel *right* for the job. Extremely durable . . . highly resistant to heat, corrosion, oxidation . . . guaranteed to register true temperature-E.M.F. values within specified close limits.

That's only part of Hoskins' product picture, though. Other specialized quality-controlled alloys developed and produced by Hoskins include: Alloy 785 for brazing belts; Alloy 717 for facing engine valves; special alloys for spark plug electrodes; Alloy 502 for heat resistant mechanical applications. And, of course, there's Hoskins CHROMEL . . . the *original* nickel-chromium resistance alloy used as heating elements and cold resistors in countless different products.

Heating elements made of Hoskins Chromel deliver full-rated power throughout their long and useful life.

Sparks fly better, last longer in today's spark plugs . . . thanks to Hoskins' spark plug electrode alloys.



Hot stuff for hot jobs! Hoskins Alloy 502 is ideally suited to many mechanical-structural applications.

Chromel®
NICKEL CHROMIUM
WIRE

HOSKINS
MANUFACTURING COMPANY
4445 LAWTON AVENUE, DETROIT 2, MICHIGAN

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the LOWEST COST
Dye Penetrant
Inspection

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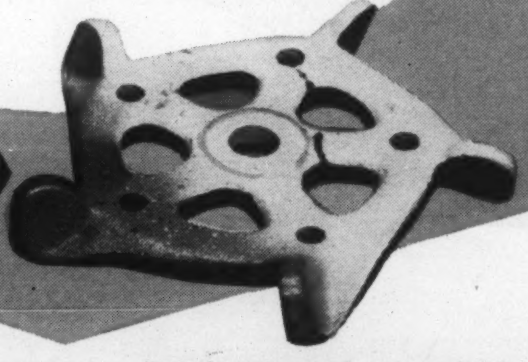
by MAGNAFLUX

Ends Guesswork Arguments!

Locates and marks cracks — seams — porosity — laps, etc. — when open to the surface . . . Use it on metals — carbides — plastics — ceramics or practically any other non-porous solid.

Brush-
Dip-
or Spray



CHECK THESE LOW PRICES

Typical casting crack as revealed by Spotcheck in sampling or maintenance inspection

Quantity	Cleaner		Penetrant		Developer	
	Single Can	Case Lots	Single Can	Case Lots	Single Can	Case Lots
12 oz. Pressure Can	$4.50 ea.	(12 cans) $2.00 per can	$4.50 ea.	(12 cans) $2.50 per can	—	—
Pint Cans	—	—	$4.00 ea.	(12 cans) $2.25 per can	$4.00 ea.	(12 cans) $2.00 per can
Quart Cans	—	—	$6.00 ea.	(5 cans) $4.00 per can	$5.00 ea.	(5 cans) $3.00 per can
1-Gallon Cans	$3.00 ea.	(10 gallons) $2.50 per gal.	$15.00 ea.	(10 gallons) $14.00 per gal.	$9.00 ea.	(10 gallons) $8.50 per gal.
5-Gallon Cans	$2.50 per gal.	(50 gallons or more) $2.00 per gal.	$13.00 per gal.	(50 gallons or more) $10.00 per gal.	$7.50 per gal.	(50 gallons or more) $7.00 per gal.

All prices F.O.B. Chicago, Illinois. Spotcheck Inspection requires application of Cleaner, Penetrant and Developer. Order quantity desired of each on your company purchase order.

Also complete kits for
HANDY SPRAY
AND BRUSH
APPLICATION

$35.00 plus $1.00 shipping and handling

Eight assorted cans of Cleaner, Penetrant and Developer; accessories, instruction book and carrying case.

FOR COMPLETE KIT
ORDER NOW

MAGNAFLUX CORPORATION
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Please send........................Type SK-1 SPOTCHECK KITS at $35.00 each, plus $1.00 each, packing and shipping cost.

☐ CHECK ENCLOSED. Amount: $..
☐ Send on our P. O. Number..
☐ Send only FREE illustrated bulletin, now.

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Prices subject to applicable state or local sales tax.

News Digest

West German Sheet Metal Fabricators Studying U. S. Techniques

Ten West German sheet metal fabricating experts have arrived in the United States for a six-week study of modern American production methods in this field.

Representing management, labor and technical operations, the German team is visiting sheet rolling mills, industrial and engineering plants, foundries, research institutes and laboratories to observe developments in the American sheet metal industry which might be adapted to increase production efficiency in West Germany.

The study trip is sponsored by the Mutual Security Agency's productivity and technical assistance program in support of the economy and defense industry of the Federal Republic of Germany.

Cold rolled sheet steel is one of the most critical items in the German supply situation today. Deliveries are running seven to nine months behind schedule, and the scarcity is felt all along the line in many manufacturing industries.

The German team will study American uses and processing of sheet metal, with particular reference to material economy and productivity in drawing, punching, spinning, bending, riveting, welding and soldering operations; surface treatment; machinery and equipment; contributions to the industry by industrial research institutes; and market research developments.

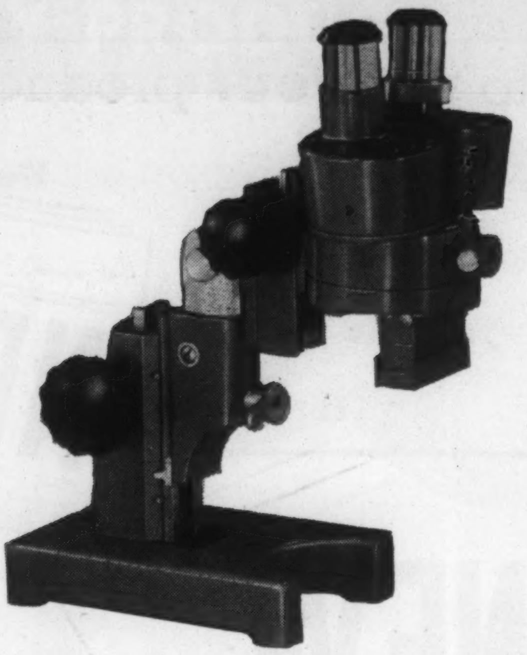
Government Engineers Report on Plastics, Lubricants, Metallurgy and Electronic Materials

Technical advances in plastics, lubricants, metallurgy and electronic materials are described in Government research reports now available to the public. A resume of each report and information on how it can be obtained follows:

"Radome Materials Research and

Let these 3 OPTICAL AIDS answer your PRECISION PRODUCTION PROBLEMS

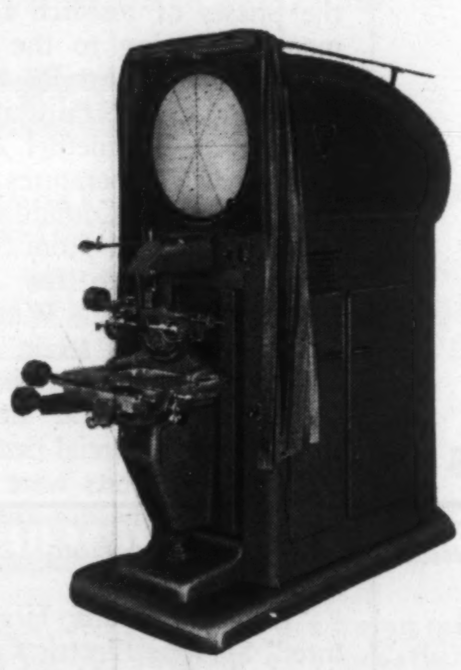
①



INDUSTRIAL STEREOMICROSCOPE

You save time and money by achieving greater speed and precision accuracy in small parts assembly operations . . . and in inspection of tools and finished parts . . . with this sturdy, dustproof instrument. *The finest optical system ever produced for stereoscopic work* assures you of accurate results. You get clear, sharp, three-dimensional images, and a *wider critical focus than ever before.* The *unreversed,* magnified image is more easily interpreted by the average user. Optical head is furnished in several different mounts for incorporating into machine tools and inspection setups. Write for catalog D-1029.

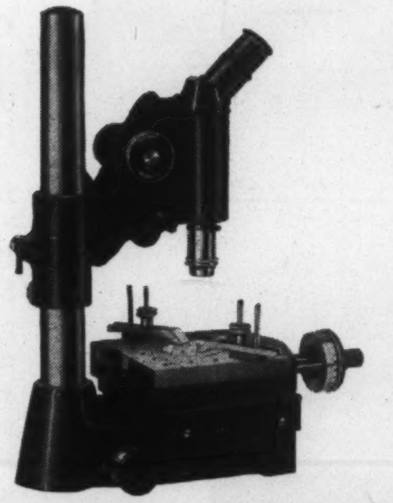
②



CONTOUR MEASURING PROJECTOR

No other projector can match its accuracy: angular measurements to ± 1 minute of arc with a protractor screen, and direct linear measurements to ± .0001″ over a range of 4″ x 6″ with the cross slide stage. Dimensions, angles, and profiles of production-run parts can be compared directly with a *traced outline* of the projected image of the master part, or with a large scale drawing superimposed on the screen. Inaccuracies are quickly spotted. Write for catalog D-27.

③



TOOLMAKERS' MICROSCOPE

This sturdy microscope gives you one inch linear measurements to ±.0001″ and angular measurements (with protractor eyepiece) to ± 1 minute of arc. Operation is extremely *simple* and *fast.* Opaque and transparent objects of any contour can be measured. Write for Catalog D-22.

WRITE for complete information on these three important optical aids designed to save you time and money. You may be paying many times over their moderate cost in lost time and rejects. Bausch & Lomb Optical Co., 79314 St. Paul St., Rochester 2, N.Y.

1853/1953 INTO A NEW CENTURY OF OPTICAL PROGRESS

BAUSCH & LOMB CENTENNIAL

Bausch & Lomb *Quality Control* Instruments

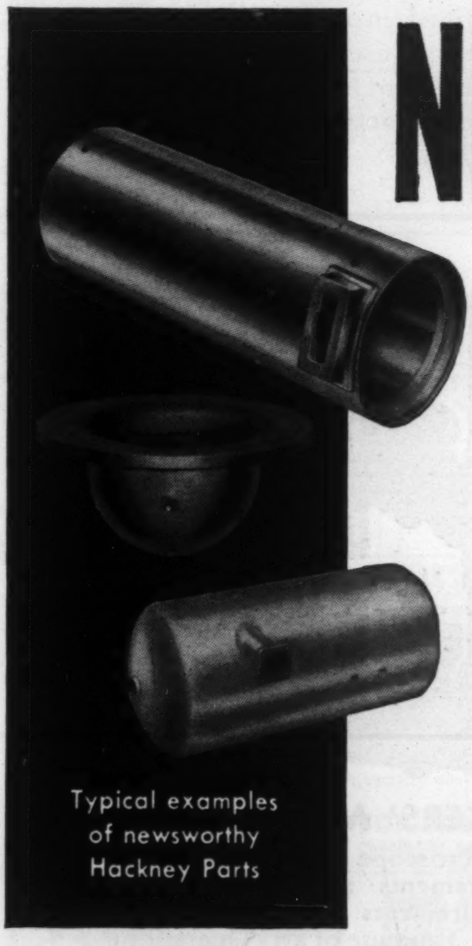
how to put **your** product

in the

with **NEW** features

NEW advantages

NEW selling points



Typical examples of newsworthy Hackney Parts

Check into the successful experience of other manufacturers who have put their products in the headlines by replacing a heavy cast, forged or welded pipe part with a lightweight Hackney seamless drawn part.

By specifying Hackney Deep Drawn Shapes and Shells, designers of many types of equipment have developed new quality standards . . . new strength and durability . . . new streamlined appearance . . . new seamless construction . . . new, lower unit costs . . . and other easier-to-sell advantages.

Write today for further information.

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Manufacturer of Hackney Products

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559 Roosevelt Bldg., Los Angeles 17
18 W. 43rd St., Room 11, Kansas City 11, Mo.

Hackney
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CONTAINERS FOR GASES, LIQUIDS AND SOLIDS

News Digest

Fabrication Development Service. Final Engineering Report." Goodyear Aircraft Corp. Available from Library of Congress, Photoduplication Section, Washington 25, D. C. Microfilm $3.00, Photostat $8.75. Treats radar dome materials, erosion resistance of protective coatings, synthetic rubber coatings, and electrical properties of chemical foams. Report PB 107372.

"Foaming-in-Place of Alkyd Resins for Sandwich Radomes. Final Engineering Report." Goodyear Aircraft Corp. Available from Library of Congress, Photoduplication Section, Washington 25, D. C. Microfilm $3.00, Photostat $8.75. Includes the phases of research and development pertaining to the alkyd-iscoyanate foam. Report PB 107373.

"Stress and Strain at Onset of Crazing of Polymethyl Methacrylate at Various Temperatures." U. S. National Advisory Committee for Aeronautics. Available from National Advisory Committee for Aeronautics, 1724 F St. N. W., Washington 25, D. C. Stress and strain at the onset of crazing were determined for both general-purpose and heat resistant grades of commercial cast polymethyl methacrylate. Tests were made at 73 to 122 F, whereas there was no consistent trend from 122 to 158 F. Report PB 107436.

"Dielectric Films, High Temperature." Sprague Electric Co. Available from the Library of Congress, Photoduplication Section, Washington 25, D. C. Microfilm $2.25, Photostat $5.00. The initial phases of the dielectric research program were concerned with preliminary studies of various types of pentachlorostyrene copolymers. Processes for the preparation of pentachlorostyrene and divinyltetrachlorobenzene are given. The first phase of the film development attached the preparation of flexible, coated foils. As a second phase of the development, stripping techniques will be worked out for the most promising dielectric coatings. A series of Ceroc-Teflon type B coated copper foils were produced on the machine adopted thereto. Satisfactory processes were worked out for the production of this type of film as an adherent coating on copper. Flexibility, toughness and dielectric strength were noted for these films. Report 107284.

"Search for New Risistive Materials for High-Stability High-Tem-

Case History MM-104

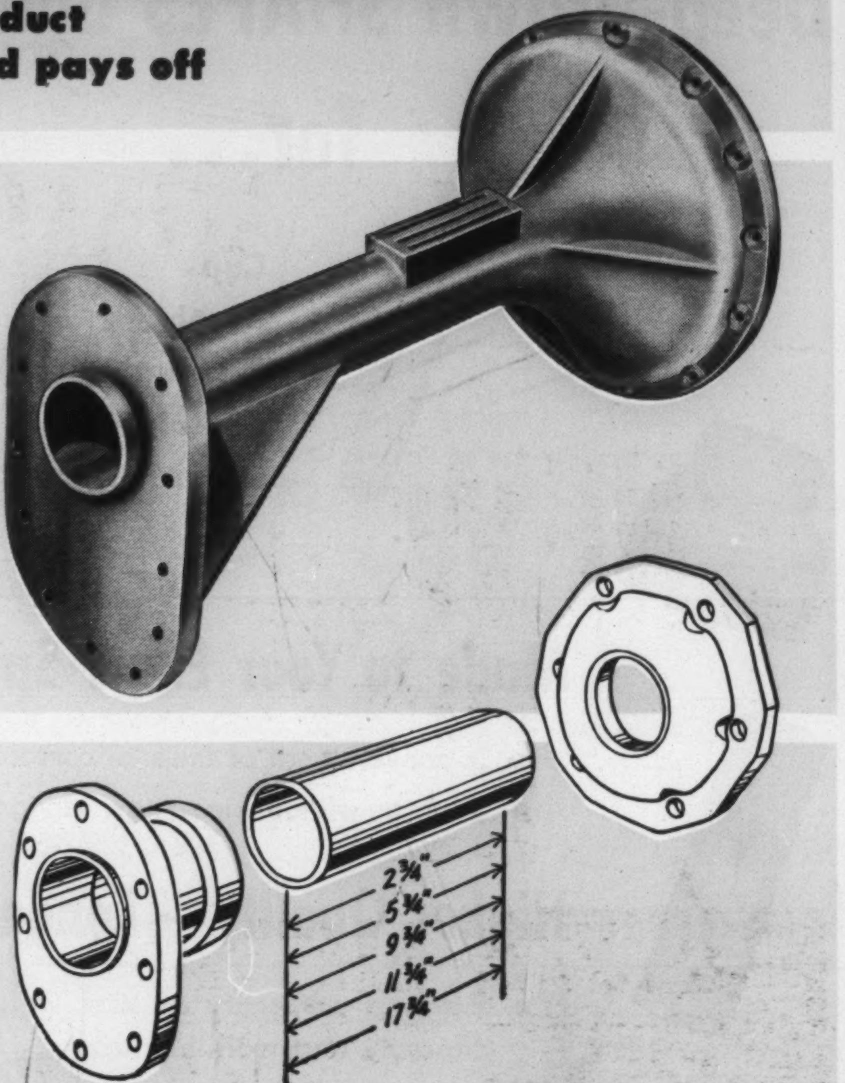
Here's what we mean by SUPERIOR ENGINEERED FOUNDRY PRODUCTS...

. . . an example of how proper product development at the drawing board pays off

PROBLEM:

Tractor Drive Spacers were required in five different sizes, making them expensive to produce as one-piece steel castings. Each size would require:

1. A separate set of expensive core boxes and pattern equipment.
2. A separate set of flask equipment . . . expensive cleaning and handling procedure.
3. A separate machining setup . . . expensive jigs and fixtures.
4. An excessive amount of critical steel . . . average weight would be 52.5 lbs.



OUR SOLUTION:

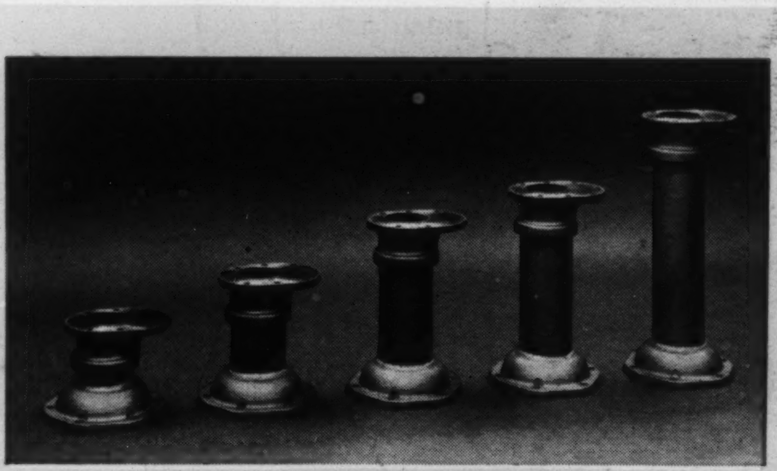
FOUNDRY ENGINEERED CAST-WELD CONSTRUCTION

Two simple machined steel castings plus one piece of pipe cut to required length and welded to the castings equals five different sizes of Spacers.

RESULT: 38.4% SAVINGS

Tractor Drive Spacers are being made in the five sizes by our foundry at a greatly reduced cost. All that is required is:

1. One set of inexpensive pattern equipment and one core box.
2. Only one size of flask equipment . . . simplified cleaning and handling.
3. One machining setup . . . one set of jigs and fixtures.
4. Less steel...average weight reduced to 37.1 lbs.



These assemblies have been proved in tough tractor service.

TOTAL COST OF PART REDUCED 38.4%

YOU, TOO, CAN GET SAVINGS LIKE THESE! CONSULT OUR PRODUCT DEVELOPMENT SECTION REGARDING YOUR PROBLEM . . . WHILE IT'S STILL ON THE DRAWING BOARD

Let our foundry engineers help you conserve critical materials.

LET OUR FOUNDRY ENGINEERS HELP YOU CONSERVE CRITICAL MATERIALS

SUPERIOR STEEL AND MALLEABLE CASTINGS CO.

BENTON HARBOR, MICHIGAN, U. S. A.

ENGINEERED FOUNDRY PRODUCTS

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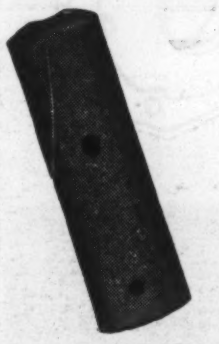

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News Digest

perature Operating Resistors." Battelle Memorial Institute. Available from Library of Congress, Photoduplication Section, Washington 25, D. S. Microfilm $2.00, Photostat $3.75. Studies show that the properties of the Cr-N films are more than slightly dependent on the characteristics of the ceramic base. This is particularly true for thin films which exhibit the desired low temperature coefficients of resistance and high resistances. Analytical information from both chemical and x-ray studies reveals that conversion to Cr^2N occurs at the high temperatures and Cr^2N plus CrN at the lower tempertures. Other thermochemical data on the Cr-N system are discussed. Report PB 107355.

"Electrical Properties of Pentachlordiphenyl-Impregnated Glass Fiber Paper." U. S. Naval Research Laboratory. Available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Mimeo $.50. In an effort to determine the effectiveness of glass fiber paper when used as a thermally stable dielectric in capacitors, a study was made of the electrical properties of the glass, the impregnant, the glass fiber paper, and the impregnated paper. When impregnated with penthachlordiphenyl (dielectric constant, 3.0 to 5.5; loss factor 0.05 to 1.0), the electrical properties of the glass fiber paper are lower than those predicted by the appropriate equations. Report PB 111030.

"High-Temperature Lubrication of Electric Motor Ball Bearings." Available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Mimeo $2.25. Indicates the best operating temperatures for glass-silicone electric motors and describes how these were arrived at. States how well older types of lubricants and newer high-temperature greases stood up at these temperatures. Included also are: a government specification on lubricants suitable for these high-temperature operating electrical machines; a discussion of the mechanism of lubrication at these higher operating temperatures; and recommendations for preparation of greases, for design of motor structures, and for design of motor bearings suitable for the high temperature operation of silicone-glass insulated machines. Report PB 111015.

"Titanium - Maganese, Titanium-

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Our experience in this business of high alloy castings goes back to 1922 and we also pioneered work in the centrifugally cast high alloys which we inaugurated back in 1931. So we have much to offer those requiring chrome-iron, chrome-nickel and nickel-chrome castings. Plenty of experience, skilled metallurgists and foundrymen, modern testing and analytical facilities, and one of the most up-to-date and fully equipped high alloy foundries in the country.

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News Digest

Tungsten and Titanium - Tantalum Phase Diagrams". Battelle Memorial Institute. Available from Library of Congress, Photoduplication Section, Washington 25, D. C. Microfilm $3.00, Photostat $8.75. Investigations were carried out on the phase diagrams for the binary alloy systems of Ti-Mn, To-W and Ti-Ta using both iodide titanium and Process A titanium metal bases. Studies were carried out, where possible, on alloy strip fabricated from the ingots by hot rolling. Metallographic, x-ray diffraction, and resistance temperature methods were used in the investigation, and tentative diagrams for the three alloy systems have been constructed from these data. The alloy systems of manganses, tungsten and tantalum with iodide titanium are similar to those found using Process A titanium. Work with iodide titanium indicates that the beta phase forms a terminal solid solution. Preliminary work on higher manganese alloys shows that several other intermediate phases exist in this system. Work with both bases indicates that beta titanium is isomorphous with both tungsten and tantalum. PB 107335.

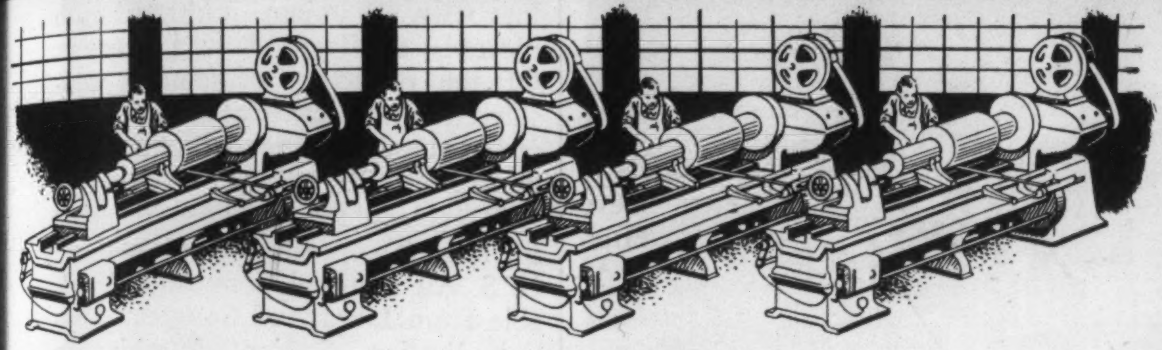
"Protective Coating of Molybdenum." U. S. Air Material Command. Available from Library of Congress, Photoduplication Section, Washington 25, D. C. Microfilm $2.00, Photostat $3.75. The final report is presented on experiments carried out to find a protective coating for molybdenum which would prevent its oxidation in air at temperatures up to 3000 F. Results are given for different ceramic coatings and for various methods of applying the coatings. The most satisfactory coatings obtained were eutectic mixes of MgO, SiO_2 and Al_2O_3. PB 107259.

"Refractory Metal Reinforced Super Alloys." U. S. Air Material Command. Available from Library of Congress, Photoduplication Section, Washington 25, D. C. Microfilm $2.00. Photostat $3.75. The results of an investigation regarding the development of heat resistant alloys by means of the infiltration of heat and corrosion resistant metals or alloys into a skelton body of a refractory metal or alloy are presented. It was also desired to develop techniques for the production of specific components from the materials de-

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation



Output up 150 pct with Red Sabre Bits

Four identical lathes, side by side, produced identical parts in one of our customer's shops. Using both high-speed steel and carbide tool bits, the rate per shift was set at 150 pieces per machine by the time-study engineers.

One of the lathe operators heard about our Red Sabre tool bits from a friend. So he brought one to work and began using it. He surprised himself by finishing 325 pieces in one shift, earning a nice bonus.

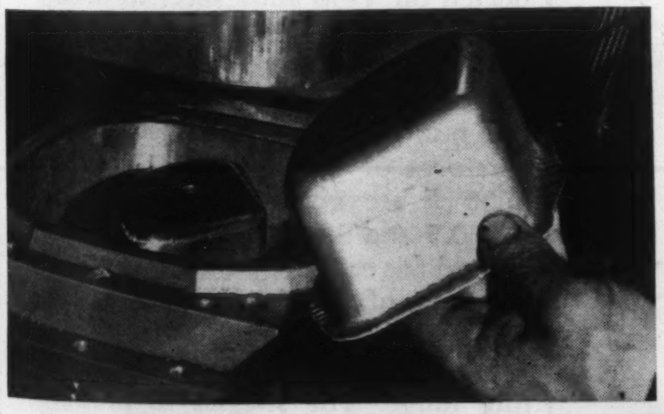
When he kept up his high rate, the payroll department began to ask questions. But a check-up showed that the operator's production was being reported correctly. In fact, his output increased to an average of 370 pieces.

When the time-study men got to the bottom of the mystery they really became enthusiastic. Red Sabre bits were installed on all four lathes. Output reached as high as 400 by increasing speeds and feeds.

Red Sabre bits are mighty popular in this shop because both the machine operators and the management are reaping the benefits of the increased output.

Red Sabre is our super high-speed steel. It has more wear-resistance and higher red-hardness than run-of-the-mill tool bits. Red Sabre tool bits, hardened to a minimum of Rockwell C-65 and ground accurately, are available in all standard sizes.

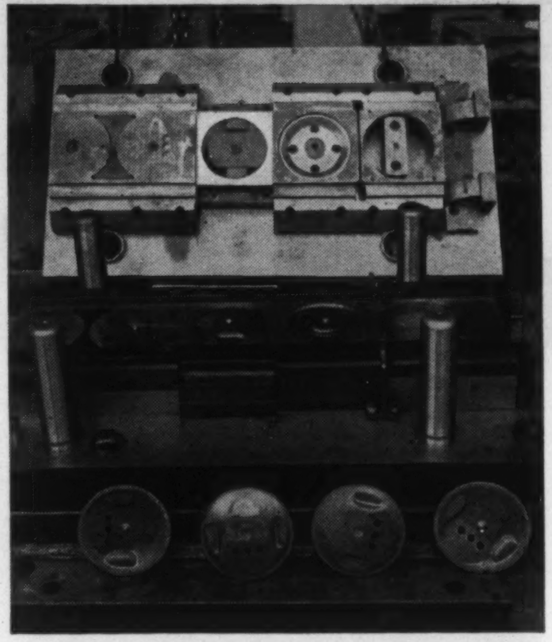
Like to try them in your shop? Order a couple from us at Bethlehem, Pa., or ask your distributor about a trial.



◀ (Left) A kitchen-ware maker uses BTR* for the die that blanks and draws .032-in. aluminum to accurate size. The fit between the die halves is held to close tolerance to assure proper flow of metal during the one-stroke draw and to produce a smooth surface. This die has produced more than half a million pieces.

(Right) In a single operation these piercing dies, made of our BTR* tool steel, put 125 holes in the aluminum accessory for pressure cookers shown at the right. The punches were in excellent alignment after heat-treatment, and showed little evidence of wear after producing 165,000 pieces without requiring regrinding. ▶

*BTR is an economical, general-purpose tool steel. Oil-hardening, it's easy to machine and heat-treat. Tough and wear-resisting, it's low in distortion.



HIGH-PRODUCTION DIE

This blanking, drawing, and forming die is made of high-carbon, high-chromium tool steel (our Lehigh H) to make possible long production runs. Operated in a 350-ton press, it produces end caps for a refrigeration unit. Hardened to Rockwell C-60, this die turns out about 100,000 pieces from 3/16-in. steel strip before redressing is needed. An air-hardening grade of tool steel, Lehigh H provides very high wear-resistance and the least amount of distortion during heat-treatment.

BETHLEHEM TOOL STEEL ENGINEER SAYS:

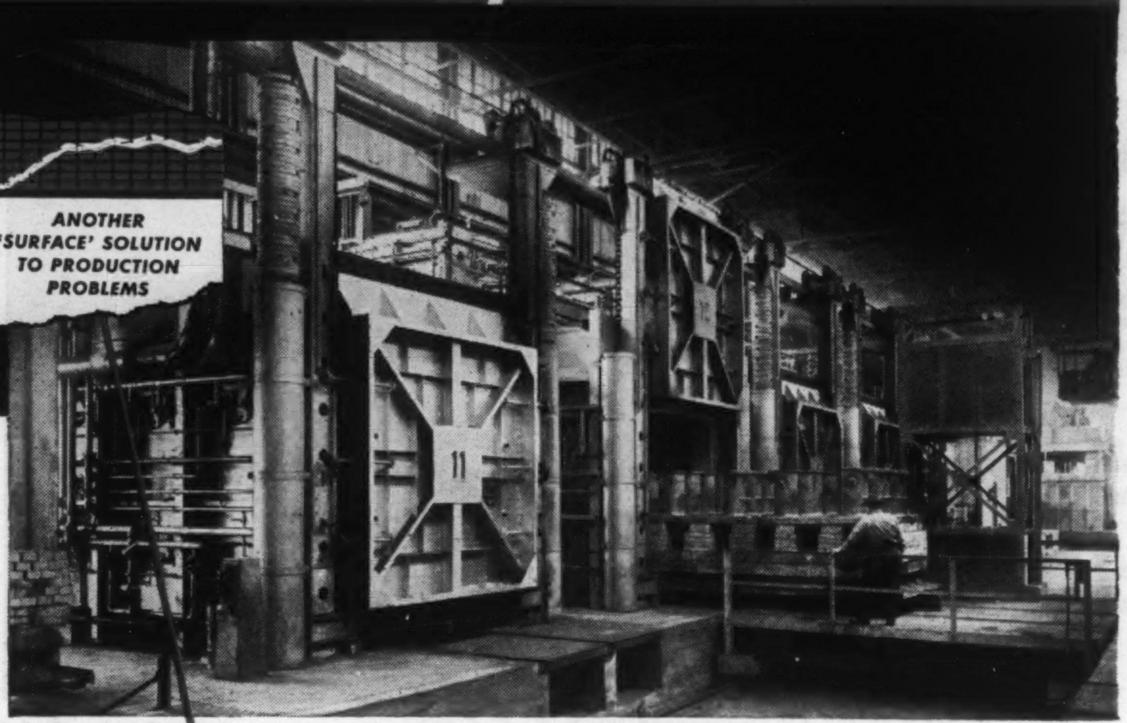
Remedy those fatigue-failures

Tools such as chisels, that are subjected to repeated stresses, often fail suddenly. As the tools are made from shock-resisting steel, these sudden failures can look mysterious. But close examination of the failed parts will often reveal that the failures were actually not sudden but occurred by progression of a crack part way through the section, followed by sudden fracture of the remaining section.

Fatigue-fractures have a characteristic, smooth-rubbed surface where the initial crack opened up, and an inner crystalline zone revealed by the final sudden break. Often the smooth-rubbed surface shows parallel "oyster-shell" markings, and may even show evidence of rusting.

Fatigue-failures usually begin at a stress-concentration point. This may be a notch, a poor fillet, tool mark, accidental nick, or a stamping. Correcting such design or mechanical faults is the cure.

'Surface'



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News Digest

veloped, which can be translated into mass production practices. Of the combinations with the refractory metals molybdenum and tungsten as major constituents, only tungsten alloys with chromium, infiltrated with nickel-base alloys, showed promise. Of the refractory compounds considered in the investigation, titanium carbide-base composites are most promising. PB 107258.

"Development of Sheet Materials for High Temperature Applications." U. S. Air Materiel Command. Available from Library of Congress, Photoduplication Section, Washington 25, D. C. Microfilm $2.25, Photostat $5.00. Tests were run on 48 alloys in order to develop a sheet material for high temperature applications which would meet the stress-rupture specifications of a 100-hr life at 1700 F, 12000 psi and 1800 F, 6000 psi. One alloy, V-36, consisting of 0.25 C, 0.80 Mn, 0.50 Si, 25 Cr, 20 Ni, 44 Co, 4 Mo, 2W and 2% Cb, fully meets the contract strength level by a slight margin. High tungsten alloys such as V-22 gave very high results in bar stock and very poor results in sheet form. Higher chromium alloys such as V-36, on the other hand, gave intermediate results in bar stock, while results in the sheet form were actually higher. PB 107255.

"V-36 Alloy: Determination of Design Data." U. S. Air Materiel Command. Available from Library of Congress, Photoduplication Section, Washington 25, D. C. Microfilm $1.75, Photostat $2.50. Creep and creep-rupture tests were conducted on V-36 alloy sheet to obtain suitable data from which design curves could be prepared. The chemical composition of V-36 alloy and results of tests conducted at temperatures of 1350, 1500, 1700 and 1800 F are given. Curves for 0.1, 0.2, 0.5 and 3.0% deformation were plotted for each temperature to facilitate use of V-36 alloy in designs where relatively high strength is needed in the 1700-1800 F temperature range. The stresses to produce rupture in 100 hr at the various test temperatures are listed. PB 107262.

"Utilization of Low Alloy Materials for High Temperature Service Applications." U. S. Air Materiel Command. Available from Library of Congress, Photoduplication Section, Washington 25, D. C. Microfilm $3.00, Photostat $8.75. Six SAE

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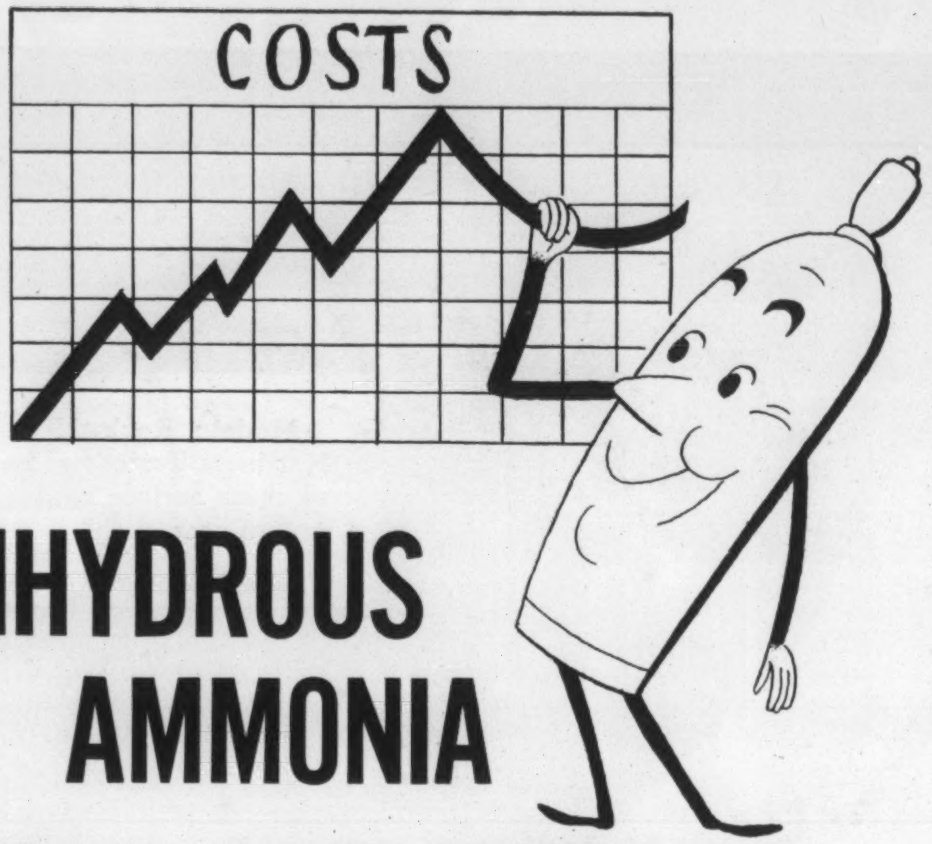

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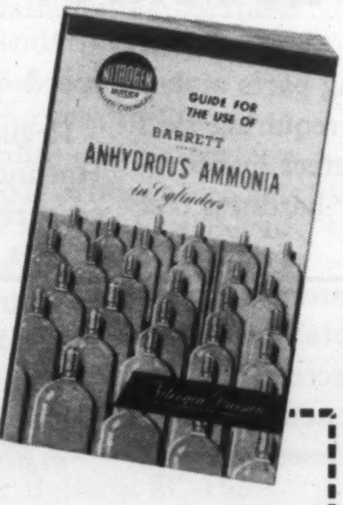

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News Digest

steels, six special ferritic steels and five stainless steels were examined in order to determine the feasibility of using these alloys for applications involving exposure to high temperatures for short periods of time. The effect of heat treatment on the high temperature properties was investigated. While the annealed condition, in general, afforded greatest resistance to relatively long time creep, it was determined that an increase in short-time strength could be made by quenching and drawing at the proper temperature. Greater high-temperature strengths were exhibited by steel containing small amounts of nitrogen or boron and titanium. PB 107260.

"Comparison of the High-Temperature Properties of ML Alloy and 142 Alloy at Room Temperature, 400 F and 600 F." Battelle Memorial Institute. Available from Library of Congress, Photoduplication Section, Washington 25, D. C. Microfilm $1.75, Photostat $2.50. The tensile properties of 142-T61 and the ML alloys have been compared at room temperature, 400 F and 600 F. Their creep properties have been compared at 400 and 600 F. The tensile properties of the 142-T61 at room temperature and 400 F are somewhat superior to ML alloy. At 600 F the tensile and yield strengths of the ML alloy are about 2000 psi higher than 142 alloy. The creep properties of 142-T61 are slightly better than ML alloy at 400 F, but at 600 F the ML alloy has the better resistance. PB 107257.

"Conference on the Applications of X-Ray Spectroscopy to Solid State Problems." University of Wisconsin (under the joint sponsorship of the Wisconsin Alumni Research Foundation, and the Dept. of the Navy, Office of Naval Research). Wisconsin Alumni Research Foundation. Available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Price $2.25. Contents: Notes on x-ray spectra and the theory of solids. Fine structure near x-ray absorption edges of crystalline matter. Improved energy band calculations for soft x-ray emission. Versatile precision bend crystal focusing vacuum x-ray spectrometer and preliminary measurements of the emission spectra of crystalline KCl. Radiative and electronic excitation of x-ray states. Absorption of selenium in the soft

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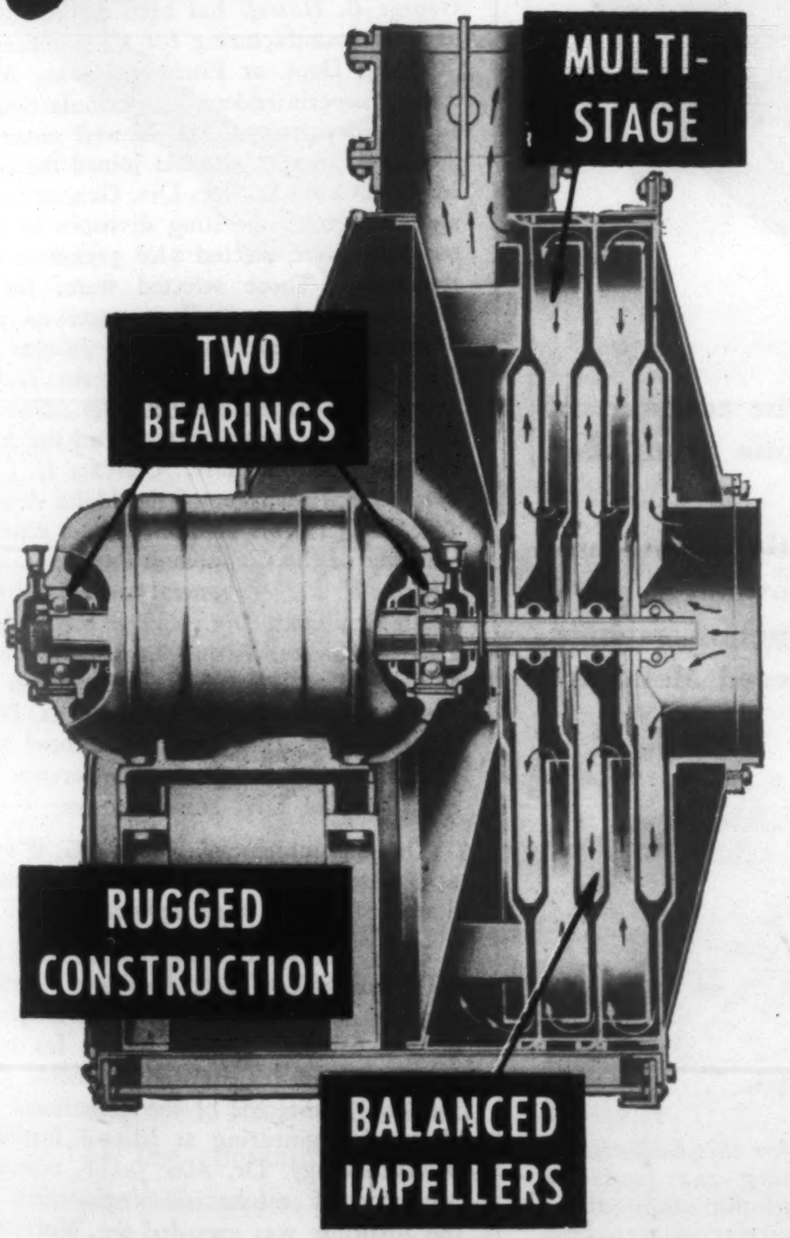

There are good reasons why the annual installation of Spencer Turbos has increased tenfold in ten years and why a recent analysis shows that repair parts amount to less than one dollar per machine per year.

No. 1. The Spencer multi-stage construction allows a smaller diameter machine with lower peripheral speeds of the fan blades and of the motor itself. The wear on the bearings is therefore cut to a minimum.

No. 2. The only rotating contacts are at the two ball bearings, which if kept greased will assure satisfactory operation without work stoppages for many years.

No. 3. Here is a machine as simple as an electric fan, with a rugged construction, as sturdy as a steel bridge and with wide clearances between the rotating elements and stationary parts. Users say "the Spencer goes on forever with little attention."

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35 TO 20,000 C.F.M.; 4 OZ. TO 10 LBS.; 1/3 TO 1,000 H.P.

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x-ray region. Absorption by aluminum in the soft x-ray region. The x-ray K absorption edges of coalently bonded Cr, Mn, Fe and Mi. PB 111027.

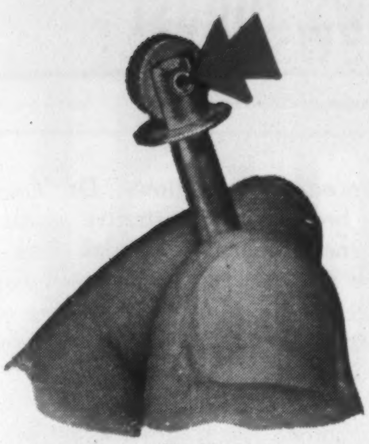
News of Engineers

The following new appointments have been announced by General Electric Co.: *George B. Howell* has been named manager of manufacturing for the company's Welding Dept. at Fitchburg, Mass. Formerly superintendent of manufacturing for the department, Mr. Howell succeeds *Thomas Sproule,* who has joined the G-E Manufacturing Services Div. General managers of eight operating divisions of the company were elected vice presidents by the board. Those selected were: *James M. Crawford,* general manager of the Motor and Generator Div.; *Francis E. Fairman,* general manager of the Transformer and Allied Products Div.; *Cramer W. LaPierre,* general manager of the Aircraft Gas Turbine Div.; *Clarence H. Linder,* general manager of the Major Appliance Div.; *Harold A. MacKinnon,* general manager of the Component Products Div.; *Charles K. Rieger,* general manager of the Small Appliance Div.; *Glenn B. Warren,* general manager of the Turbine Div.; and *William C. Wichman,* general manager of the Industrial Power Components Div. Another new appointment announced was that of *Robert L. Clark* as supervisor of the Chemical Div. News Bureau.

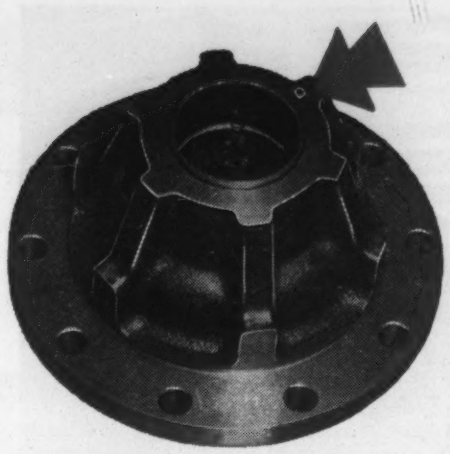
The appointment of *William G. Whyte* as assistant to vice president of United States Steel has been announced.

Dr. *J. Henry Rushton,* an authority on the chemical engineering aspects of mixing, has been named the 17th recipient of the coveted Walker Award for outstanding achievement in his field. Dr. Rushton is director of the department of chemical engineering at Illinois Institute of Technology. Dr. *Max Jakob,* research professor of mechanical engineering at the Institute, was awarded the Worcester Reed Warner medal by the American Society of Mechanical Engineers.

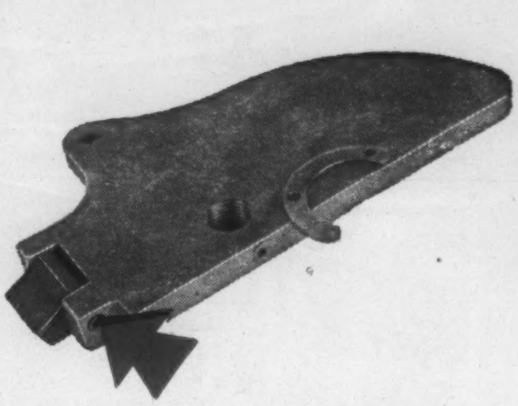
Appointment of Dr. *John C. Hecker* as vice president in charge of technical operations at the Distillation Products Industries Div., Eastman Kodak Co., has been announced. *C. L. A. Wynd* was named an assistant general manager of the company's Kodak Park Works. Mr. Wynd will share his responsibilities with *Gerould T. Lane,* also an assistant general manager of the plant. Other appointments



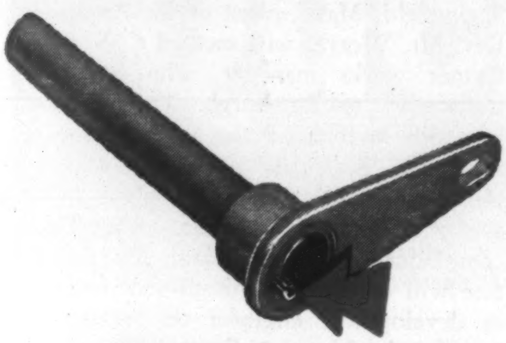
AS A SHAFT . . . Rollpin serves as an axle for the sparkwheel of a cigarette lighter. No riveting or threading necessary . . . faster assembly. Note flush, clean fit.



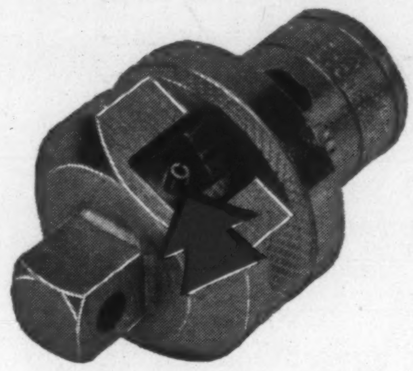
AS A DOWEL . . . Rollpin is used here to prevent rotation of a thrust bearing. No reaming, no special locking. Easily removed. Lowest possible dowel pin cost.



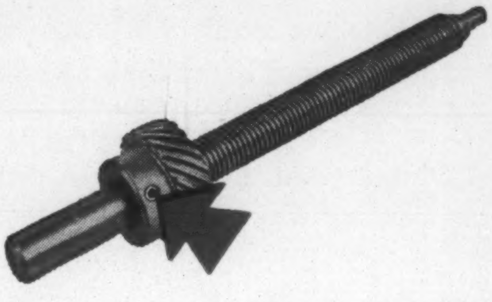
AS A CLEVIS PIN . . . here Rollpin holds firmly in clevis, permits free action of moving member. Rollpin application above is with the plate of a home workshop tool.



AS A KEY . . . Rollpin demonstrates its ability to do away with precision tolerances, in this heating system damper arm. Faster, cheaper and more satisfactory than usual assemblies.



AS A STOP PIN . . . in this application, Rollpin is shown in a ratchet wrench adaptor. With its light weight and high shear strength, Rollpin functions perfectly . . . cuts assembly costs.



AS A SIMPLE FASTENER . . . Rollpin replaces a set screw in pinning a gear to a shaft. Assembly time is shorter, service life longer. Vibration-proof flush fit. Easily removable.

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are cheaper . . . faster, with ROLLPIN

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Rollpin is a pressed-fit pin with chamfered ends. It drives easily into holes drilled to normal tolerances, compressing as driven. No reaming, no tapering, no extra assembly steps required. Rollpin fits flush, *locked* in place by the constant pressure it exerts against the hole walls. Can be inserted with automatic press, or by hand—removable with a drift or pin punch.

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Elastic Stop Nuts with the famous red collar are another ESNA product

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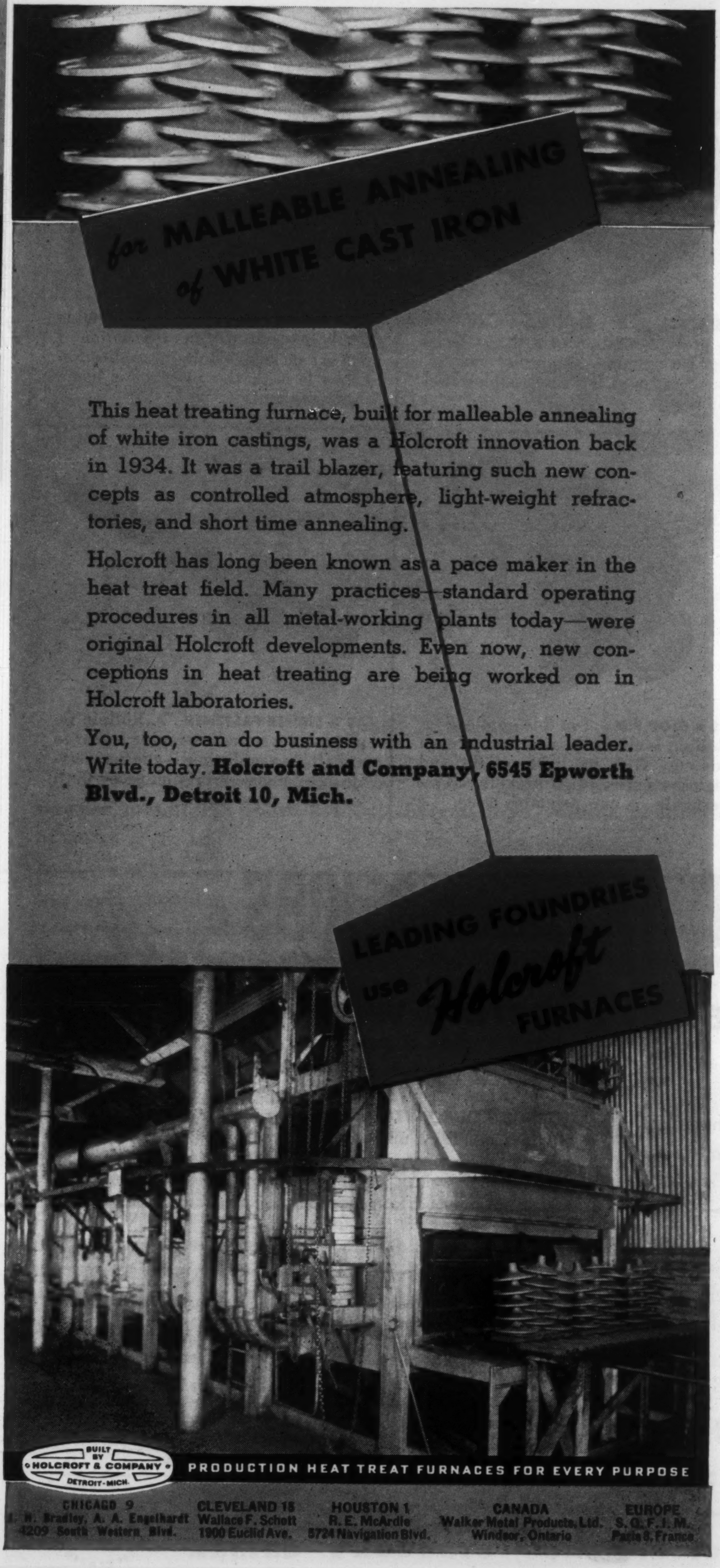
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announced are as follows: Dr. *Louis K. Eilers* becomes administrative assistant to the general manager, Kodak Park; Dr. *Austin J. Gould* has been named assistant manager of the film manufacturing organization; *Eugene R. Clearman* becomes superintendent of the Roll Coating Div. Another announcement from the company makes known the retirement of *Myron J. Hayes*, vice president and general manager of the company's Camera Works, Hawk-Eye Works, and Navy Ordnance Div.

According to a recent announcement from Westinghouse Electric Corp. *J. R. Weaver* has been named manager of manufacturing and engineering for the Springfield, Mass., plant of the Appliance Div. Mr. Weaver will succeed *C. B. Dick*, former works manager, who has been transferred to Pittsburgh. The company has also announced the appointment of *Richard E. Ballentine* as plant manager of the new welding-electrode plant being constructed at Montevallo, Ala. Until completion of the new plant, Mr. Ballentine will continue in his present function as development engineer on brazing alloys for the Motor & Control Div.

Allis-Chalmers Manufacturing Co. has announced the appointment of *Wilbur F. Koester* as manager of the Plant Engineering Dept., General Machinery Div. The company also has announced that *Gerald E. Smart*, a plant engineer at the Norwood, Ohio, Works, has been placed in charge of the plant engineering department there.

Hal R. Sheaffer has joined the staff of Metals Disintegrating Co., Inc. as manager of pigment development.

Appointment of *Dan A. Ringis* as plant manager of the Chrysler Motors, Los Angeles, Calif., plant has been announced. Mr. Ringis succeeds *C. C. Rowles*, who is assigned special duties on the staff of *F. L. DeCavitte*, operating manager of the entire Plymouth Div.

The appointment of works managers for the two Toledo plants of Doehler-Jarvis Corp. has been announced. *John W. Thees*, formerly plant manager of the company's Chicago plant, will become works manager of the Toledo Plant #1, and *Charles I. Hodgson* has been named works manager of Plant #2.

Frederick G. Huxster has been named manager of chemical operations for the Explosives Dept., Hercules Powder Co. Mr. Huxster will succeed *J. Leroy Bennett*, who is retiring.

Richard L. Hoff has been appointed development metallurgist by Superior Tube Co. Mr. Hoff was formerly in charge of welding research at the Naval Air Experimental Station in Philadelphia, and previously, was a metallurgist at the Oak Ridge National Laboratory. Another appointment announced by the company is

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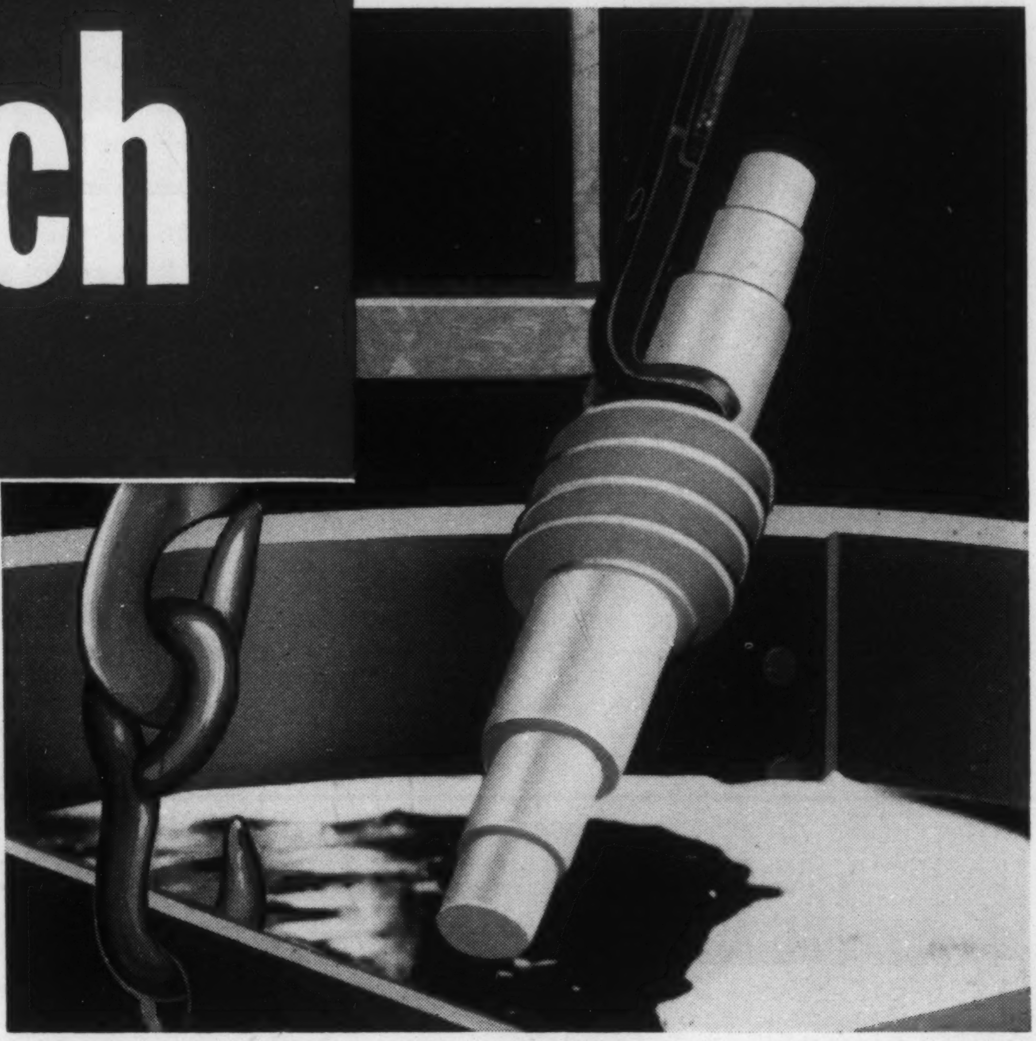

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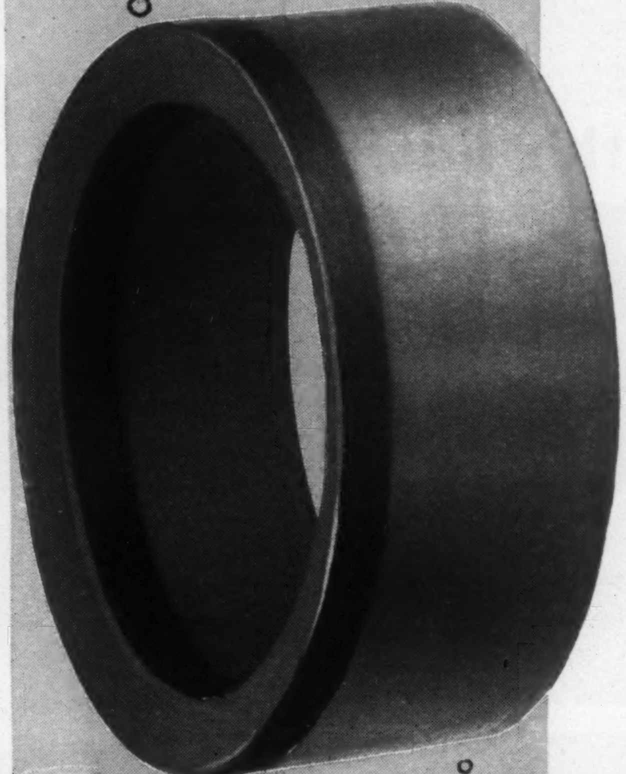

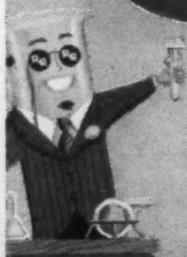

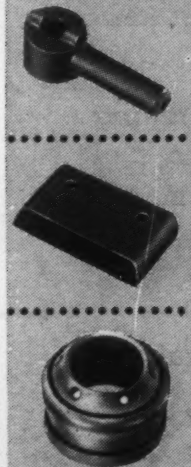

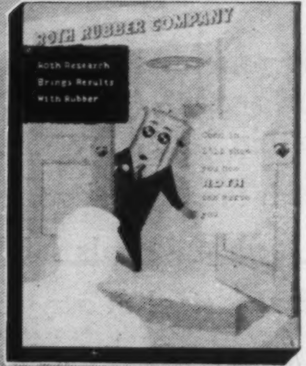

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News Digest

that of *Harry W. Poole* as director of quality control.

Appointment of *Francis W. Theis* as director of development for the Barberton, Ohio, plant of Columbia-Southern Chemical Corp. has been announced. Mr. Theis succeeds *F. R. Elmore,* who will serve as a consultant to the Columbia-Southern plant at Corpus Christi.

Three top administrative promotions at Pittsburgh Plate Glass Co.'s research laboratories have been announced: *E. Lester Fix,* associated with the glass division's research operations since 1928, has been appointed associate director of research; *Brooks J. Dennison* has been appointed assistant director of research and will be principally concerned with the general laboratory activities. Also appointed assistant director of research is Dr. *James E. Archer,* who will assume direction of the expanded program of fundamental research.

Calresin Corp. has announced the appointment of *Douglas Wilkings* as production manager of the Arcadia, Calif., plant. Mr. Wilkings was the founder of New Plastic Corp.

Dr. *Robert B. Sosman,* professor at Rutgers University, and noted ceramist and authority on silica and refractories, has been named the 1953 recipient of the Albert Victor Bleininger Award.

R. J. S. Pigott, director of engineering, Gulf Research & Development Co., has announced his intention to retire from that position. He will, however, continue in the capacity of consultant.

Announcement has been made of the appointment of *Robert Guelcher* as industrial engineer by the Ajax Flexible Coupling Co., Inc.

The appointment of *Ronald W. Post* to director of engineering, Boonton Molding Co., has been announced.

New plant managers have been appointed to direct manufacturing operations at two of the four plants comprising the newly formed Yale Lock and Hardware Div., Yale & Towne Manufacturing Co. They are: *Hugh J. Mathews,* plant manager at Stamford, Conn., and *John E. Charleson,* plant manager at Lenoir City, Tenn., where a new factory is now under construction.

J. V. Naish was recently elected executive vice president, Consolidated Vultee Aircraft Corp.

Appointment of *Paul B. Wishart* to the newly created position of general manager of Minneapolis-Honeywell Regulator Co. and his election to the board of directors has been announced. Mr. Wishart continues as vice president. *Glenn E. Seidel* has been elected a vice president of the company in charge of engineering in the company's Minneapolis plants.

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News Digest

Appointment of three group leaders to the Research and Development Dept., Olin Cellophane Div., Olin Industries, Inc., has been announced. The new leaders and their assignments are: Dr. *Preston M. Kampmeyer,* cellophane research; Dr. *Walter S. Kaghan,* process development; and Dr. *George R. Mitchell,* coating research.

W. A. Del Mar, chairman of research and development committee of Phelps Dodge Copper Products Corp., and chief engineer of the Habirshaw Cable & Wire Div. of that company, has returned from London where he received the Fellowship of the City and Guilds of London Institute, the diploma of which was presented to him by Prince Philip, Duke of Edinburgh.

Whittaker, Clark & Daniels, Inc. has announced the appointment of *Arthur N. Sudduth* as manager of the company's new Abrasive Div.

Two additional development engineering assignments with the Goodyear Atomic Corp. have been announced by Goodyear Tire & Rubber Co. *William H. Taylor* has been named as superintendent of design and development and *Howard L. Caterson* has been named head of inspection. Both men will report to *D. H. Francis,* director of the Development Engineering Div.

Appointment of *John M. Bandel* as vice president of Electro Metallurgical Co. has been announced.

Edward Gardiner has recently been named a director of Electro Devices, Inc. along with being appointed chief engineer of that company's Servospeed Div.

Carl E. Rowe of Milwaukee, who has been engaged in various phases of consulting engineering and in foundries in the middle west, has established his own consulting engineering firm, Carl E. Rowe & Co., with offices at 125 E. Wells St., Milwaukee 2.

Two new assignments to key engineering posts have been announced by AiResearch Manufacturing Co., a Garrett Division. *Helmut Schelp* was named to investigate and screen new products for manufacture, and *W. T. von der Nuell* will supervise engineering and industrial development of new products for commercial markets.

Hanson-Van Winkel-Munning Co. has announced the appointment of *Thomas J. Menzel* to the position of manager, electroplating section.

Michael Pinto has been named president of Pioneer Engineering and Manufacturing Co., Inc., succeeding *A. M. Sargent,* who founded the company. In acquiring Pioneer from Sargent, Mr. Pinto, who is also president of Douglas Tool Co., Detroit, emphasized that no

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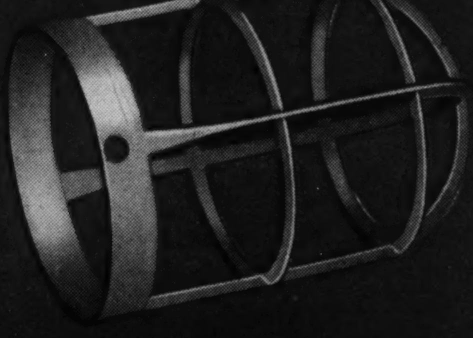

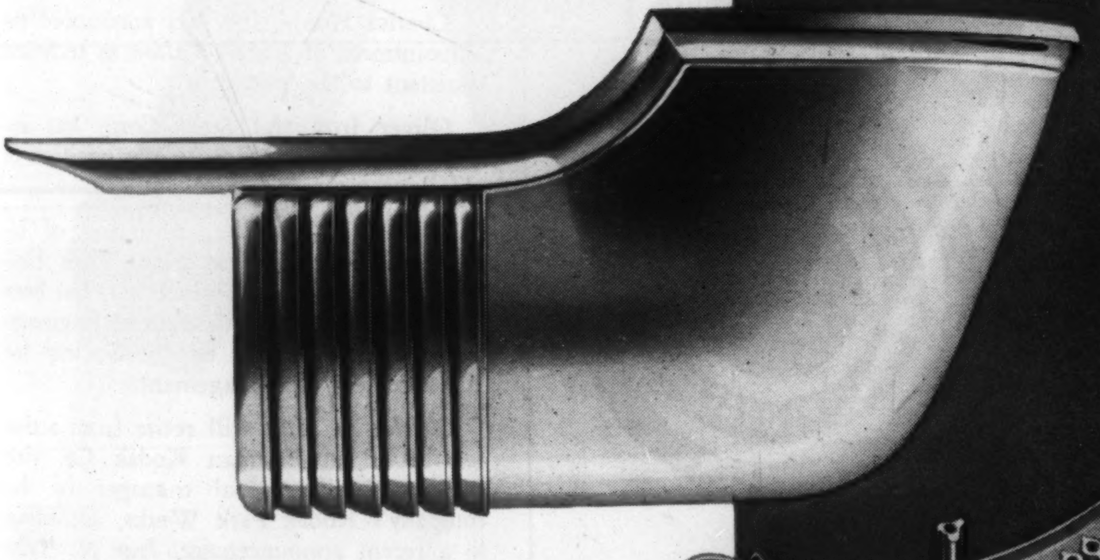

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News Digest

changes in policies are contemplated for the company. His first action was to name *Clyde Mooney*, chief engineer for Pioneer since 1945, to the position of general manager in complete charge of all operations.

Dwight S. Ewalt has been elected vice president and general manager of Rust Furnace Co. to succeed the late *W. R. Culbertson*. The board of directors also elected *O. D. Rice*, manager of operations, to a directorship.

The International Resistance Co. has announced the recent promotion of *John J. Bohrer* to assistant director of research.

F. P. Strieter, former chief of the casting section of Dow's metallurgical laboratories, has been named assistant superintendent of the Die Casting Dept.

Foote Mineral Co. has announced the addition of Dr. *J. F. Haseman* to the Research and Development Staff at Berwyn, Pa.

George O. Shutzbaugh has joined the Research & Development staff of Alloy Engineering & Casting Co. as an associate director of Armed Services Research & Development Projects.

Charles Hardy, Inc. has announced the appointment of *Robert Fulton* as technical assistant to the president.

Oliver Iron and Steel Corp. has appointed *John E. Munn* to the position of development engineer.

William R. Mullee, professor of industrial engineering at New York University's College of Engineering, has been awarded the Gilbreth Industrial Engineering Medal for 1952 by the Society for Advancement of Management.

Charles K. Flint will retire from active service as an Eastman Kodak Co. vice president and general manager of the company's Kodak Park Works, according to a recent announcement. *Ivar N. Hultman*, company vice president and assistant general mnager at Kodak Park, will succeed Mr. Flint.

The appointment of *Lawrence D. Bragg, Jr.* to the office of vice president in charge of production has been announced by Bolta Products, Inc. Mr. Bragg served previously as assistant to the chairman of the board and as production manager. The company has also announced the appointment of *James D. Casey* to the office of vice president in charge of engineering. Mr. Casey served as chief engineer of the company.

Two organization changes in the manufacturing division of Solar Aircraft Co.'s San Diego plant have been announced: *Clyde W. Seymour*, formerly manager of the Production Control Dept., has been named assistant manager of the Manufacturing Div. His position will be filled by *W. Robert Bruce*, who was assistant

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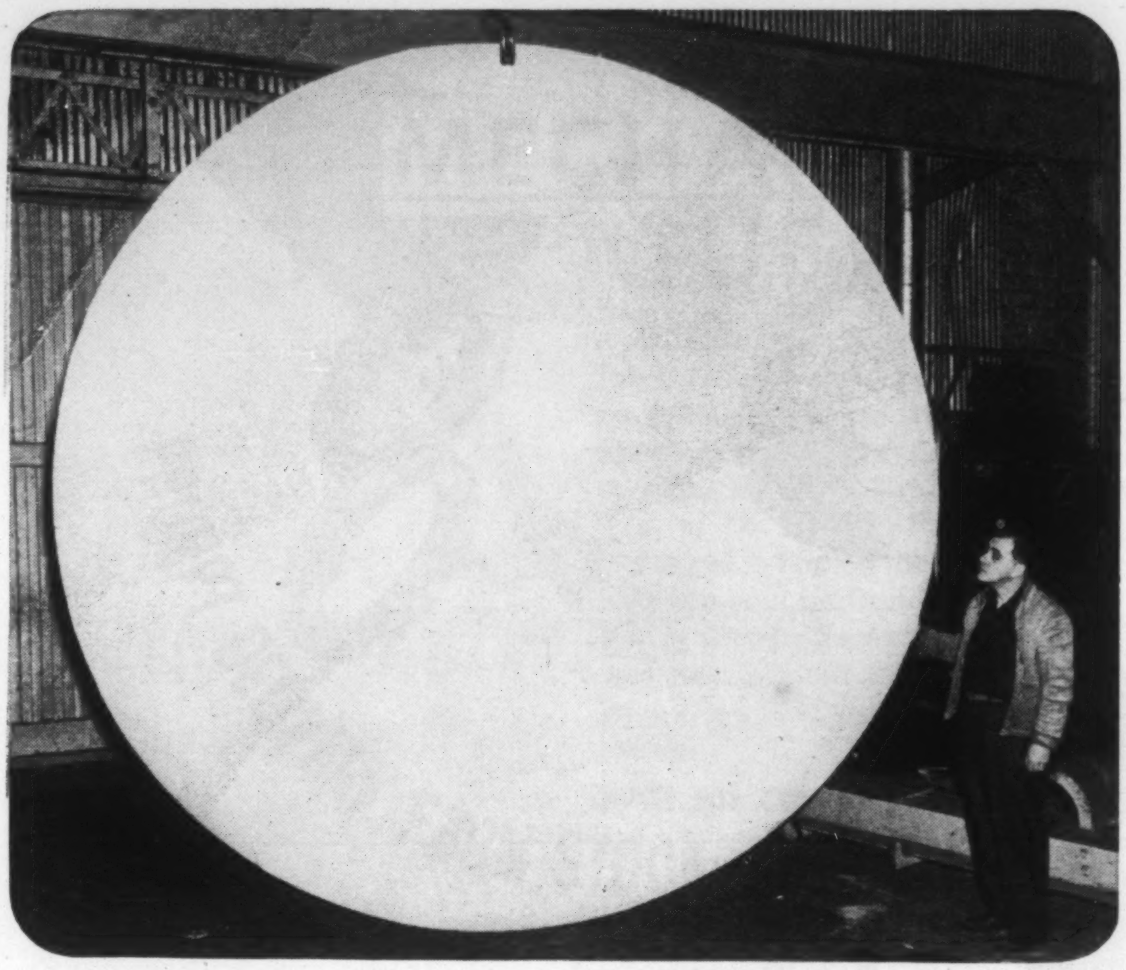

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manager of the Production Control Dept.

Robert R. Wilke and *Forrest P. Clay, Jr.* have joined the staff of the Electromechanical Div. at Atlantic Research Corp. Mr. Wilke now heads the Electronics Section and Dr. Clay joins the company as research physicist. Other new appointments were announced by the company: *Thomas J. O'Donnell* will head the Physics Section of the Electromechanical Div. and *Edwin F. Abrams* becomes physical chemist.

Rollin D. Hager has been appointed general manager of industrial products manufacturing for The B. F. Goodrich Co. *Lee D. Tidball,* former production superintendent of the division, has been appointed general superintendent, replacing Mr. Hager.

Two top scientists of the Research Laboratories of The Goodyear Tire & Rubber Co. have been assigned major duties with the Goodyear Atomic Corp., operator of the government's gigantic atomic energy plant now under construction in Southern Ohio. Dr. *Richard B. Stambaugh* will become superintendent of the Works Laboratory and Dr. *Charles R. Milone* will head the Atomic Research Laboratory. Others assigned to duties at the new installation are: *Hugh F. Porter, Jr.*, head of the Electrical and Instrument Div.; *Ralph J. Nance,* superintendent of Shops Maintenance; *Robert M. Rutherford,* head of Utilities and Utilities Maintenance; *Thomas W. Leary,* superintendent of Process Maintenance; *Arthur J. Brust,* superintendent of Planning and Scheduling; *Nathan H. Hurt, Jr.*, superintendent of Staff Engineering. *Albert J. Gracia* is manager of the new Goodyear endeavor.

Robert S. Sweeney has been named vice president and general manager of The Watson-Stillman Co., the Hydraulic Press Div. of H. K. Porter Co., Inc.

G. Krause has been appointed chief designer of Loewy Construction Co., subsidiary of Hydropress, Inc., and *H. Albers* has been promoted to chief engineer in charge of the U.S.A.F. heavy press program.

Appointment of *Daniel T. Wellman* as president of the Wellman Bronze & Aluminum Co. has been announced by *F. S. Wellman,* who moves up from president to chairman of the board.

In a general realignment of executive personnel at a recent meeting, the board of directors of H. W. Tuttle & Co. moved three men within the organization to higher positions and created the new post of works manager, appointing a new member of the company to fill this spot: *H. W. Tuttle, Jr.* becomes executive vice president; *Herbert A. Speerstra* was named vice president and director of purchases; *Warren A. Stuckey* becomes vice president and works manager; and *Max D. Rosenstein* was promoted to vice president in charge of electronic research.

Edward S. Russell, president, Consolidated Industries, Inc., has been appointed by the National Production Authority to the newly formed Titanium Producers and Fabricators Industries Advisory Committee.

W. E. Santoro has been appointed head of the Research Div., Monroe Sander Corp. Mr. Santoro was formerly associated with the Standard-Toch Chemical Co.

Setrak K. Derderian was appointed assistant general manager of Metal Hydrides Inc., according to a recent company announcement.

John G. Holschuh has been named manager of the newly created market research section, Elastic Stop Nut Corp. of America.

National Research Corp, has announced the appointments of *Philip J. Clough* as assistant director of the Metallurgical Dept., and *Russell L. Sylvester* as manager of engineering and chief engineer of the Equipment Div.

McAndrew McCall has been named chief design engineer, Construction Dept., Machinery Div., Dravo Corp.

L. F. Hickernell, chief engineer, Anaconda Wire & Cable Co., has been elected a member of the board of directors of the American Institute of Electrical Engineers.

Two top civilian experts from the Navy Bureau of Aeronautics and the U. S. Air Force have joined the Ryan Aeronautical Co., Engineering Dept. They are *G. C. Danch* who will serve as executive assistant to the director of engineering, and *Al Deyarmond,* who will again fill the reactivated post of chief of structures. In addition he will also be chief of aerodynamics.

Jackson Kemper has been appointed general manager, Watson-Stillman Fittings Div., H. K. Porter Co.

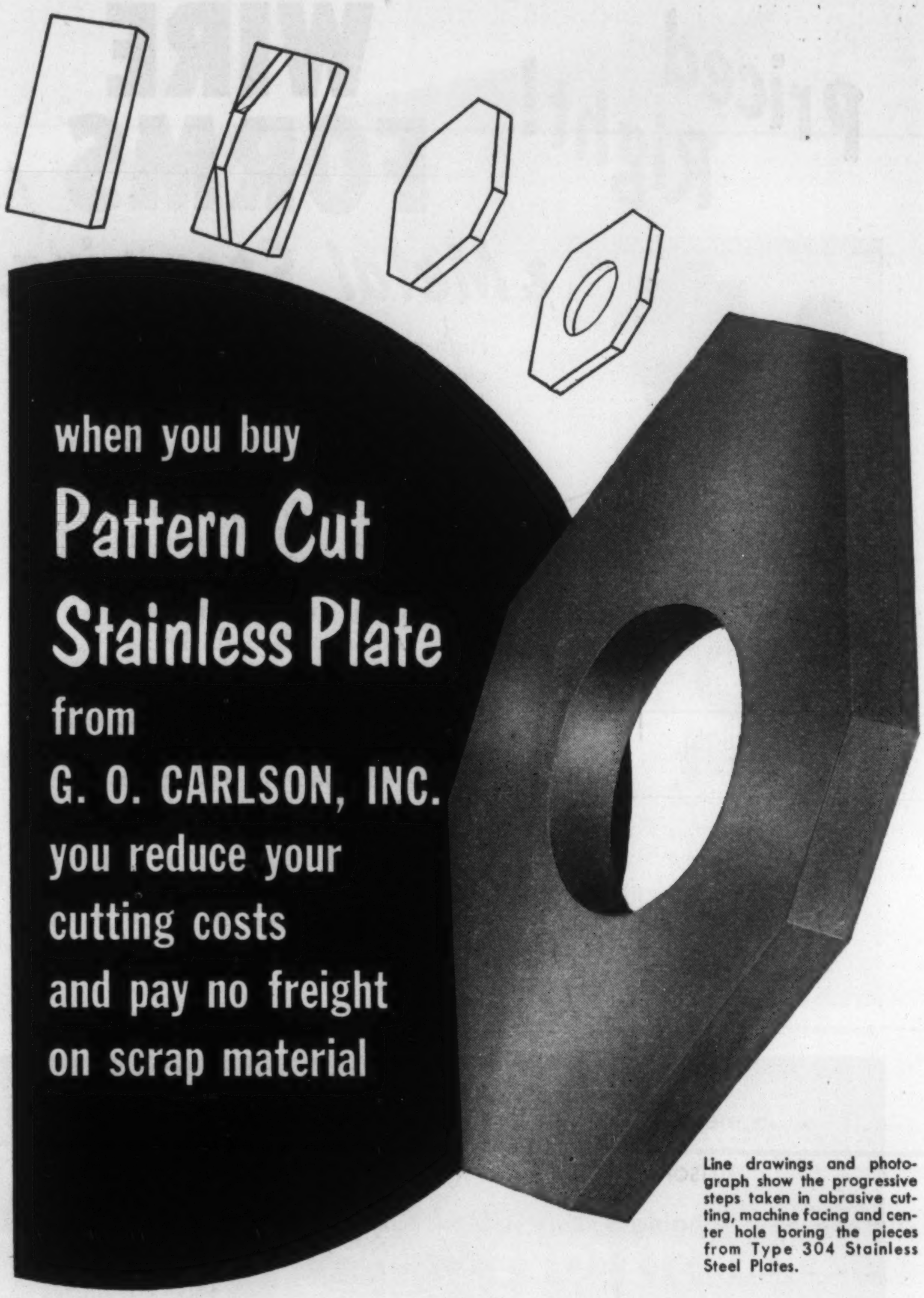
Bernard James Rainey, formerly design engineer for John Verdiun Machine Corp., has been named to the engineering staff of Auburn Button Works, Inc. He has been assigned to the company's Vacuum Forming Div.

Chrysler Corp. has announced the appointment of *Milton E. Trueman* as works manager of the Chrysler Trenton, Mich., plant. Also announced was the appointment of *Brent C. Jacob, Jr.* as supervisor of quality inspection.

T.A.B. Engineers, Inc. has announced the appointment of *Robert Bigham* and *Jack R. Clemens* as project engineers.

Paul A. Stewart, former production manager for the Globe American Corp., has been appointed to the newly-created position of production manager for the Maytag Co.

Bishop Manufacturing Co. has an-



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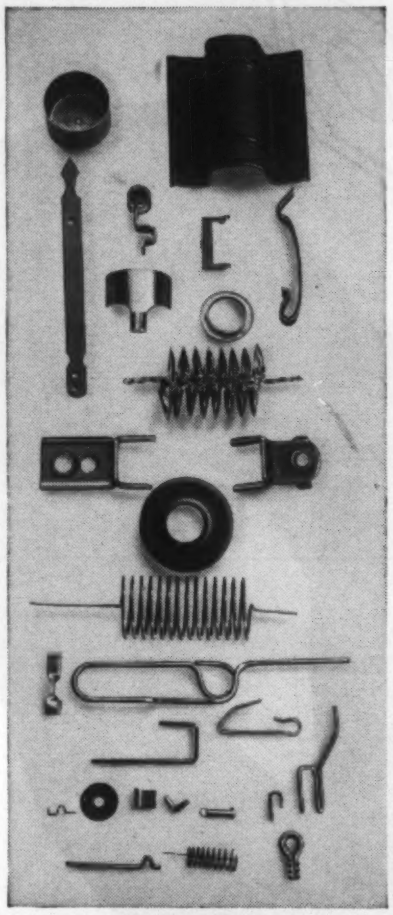

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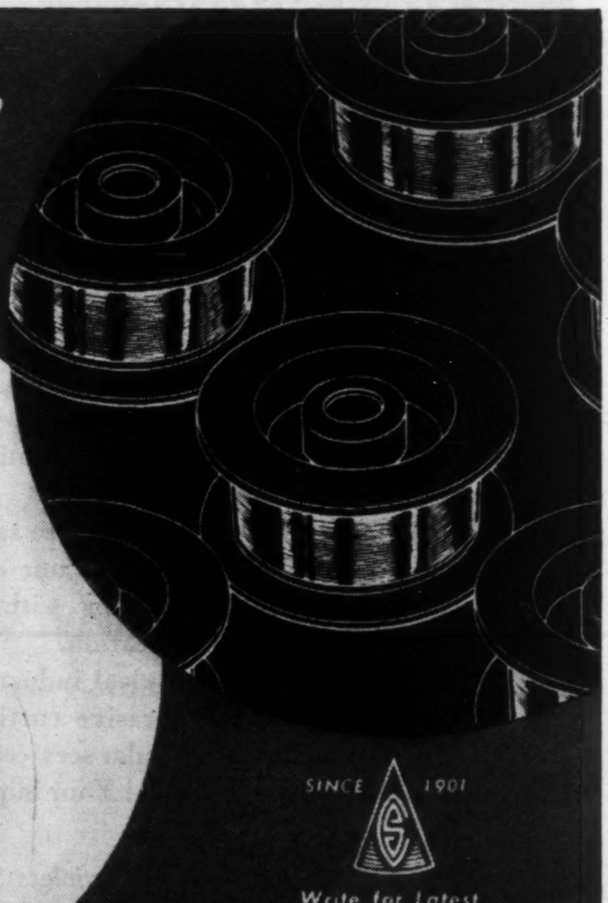

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News Digest

nounced the appointment of *Harmon H. Gillman* as technical director.

Promotion of J. Q. A. Doolittle, manager of the Watervliet, N. Y., plant of Allegheny-Ludlum Steel Corp., to an assistant to the manager of production for the company has been announced. Mr. Doolittle will be succeeded as manager of the Watervliet plant by *Arthur H. Hanks,* presently manager of the plant's new hot extrusion and stainless tubing dept.

Appointments of *H. L. Weinberg* as director of engineering for American Locomotive Co. and of *Kendall B. Rowell* as chief engineer have been announced.

Micromatic Hone Corp. has announced the following changes in staff appointments: *William J. Pinkerton,* formerly director of public and industrial relations, has been promoted to vice president in charge of manufacturing; *Arthur B. Kowalski* assumes the position of factory manager. *Joseph Bolz* and *Glen Rosene* have been appointed division superintendents.

Thomas E. Moffitt has been appointed western manager of the Hooker Electrochemical Co., and *L. J. Call, Jr.* has been appointed chief draftsman.

Harold C. Olsen has been named works metallurgist for the Los Angeles plant of the Lindberg Steel Treating Co.

A. M. Cox, president of Pittsburgh Commercial Heat Treating Co., has been elected president of the Metal Treating Institute.

John G. Steinebach, formerly a foundry engineer for the Aluminum Co. of America, has joined the Foundry Dept., Chemical Div., Borden Co.

The appointment of Dr. *Glenn H. McIntyre* and *Orville O. Kenworthy* to new key posts with the Ferro Corp. has been announced. Dr. McIntyre has been named technical director and Mr. Kenworthy was appointed director of research.

Appointment of *A. O. Williams* as director of engineering, Industrial Truck Div., Clark Equipment Co. has been announced.

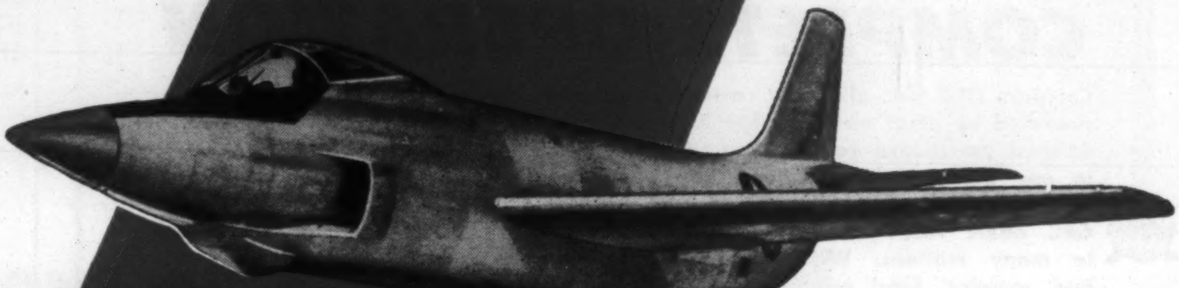
Link Welder Corp. has announced the appointment of *Harry Day* to vice president and general manager of the company.

The appointment of *Charles W. Smith* as general manager of Rodney Manufacturing Corp. has been announced.

Irving August, formerly superintendent of Worthington Corp.'s Denver plant, has been appointed assistant to the works manager of that company's Holyoke, Mass., plant. Mr. August has been succeeded by *Merril Berman.*

Donald F. Murphy has been elected a vice president of Rohm & Haas Co.

Walter J. Morris, recently superin-



once more . . . "on the nose"

ZENITH in the McDonnell Demon

Rising swiftly from the decks of Navy carriers, McDonnell's new carrier-based jet fighter, the F3H-1 "Demon," is designed to wreak havoc on the enemy. Placed in its prow is another example of rugged ZENITH reinforced plastic construction—the type of product that has brought ZENITH to the forefront in both military and civil R. P.* production.

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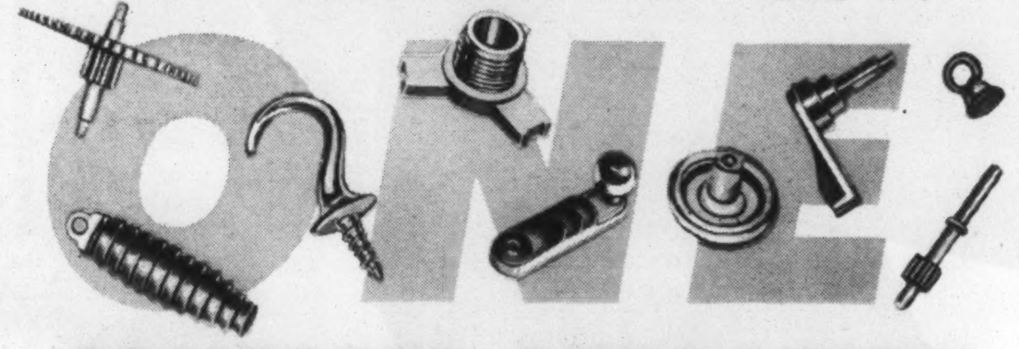

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ROLAND TEINER CO. INC. 134 TREMONT ST., EVERETT 49, MASS.

News Digest

tendent of silicon products of the Warren, Ohio, mill of Republic Steel Corp., has become associated with Tempel Manufacturing Co.

Harry T. Kessler has been made president and treasurer of the Tuthill Pump Co.

Joseph P. Somers has been appointed assistant to the president of Wyckoff Steel Co.

James T. Duffy, Jr. has been elected executive vice president of the Camden Forge Co. He was formerly president of the Riverside Metal Co., from which he recently resigned.

According to a recent announcement, *Jack M. Roehm* has been appointed director of research and development of The Kawneer Co.

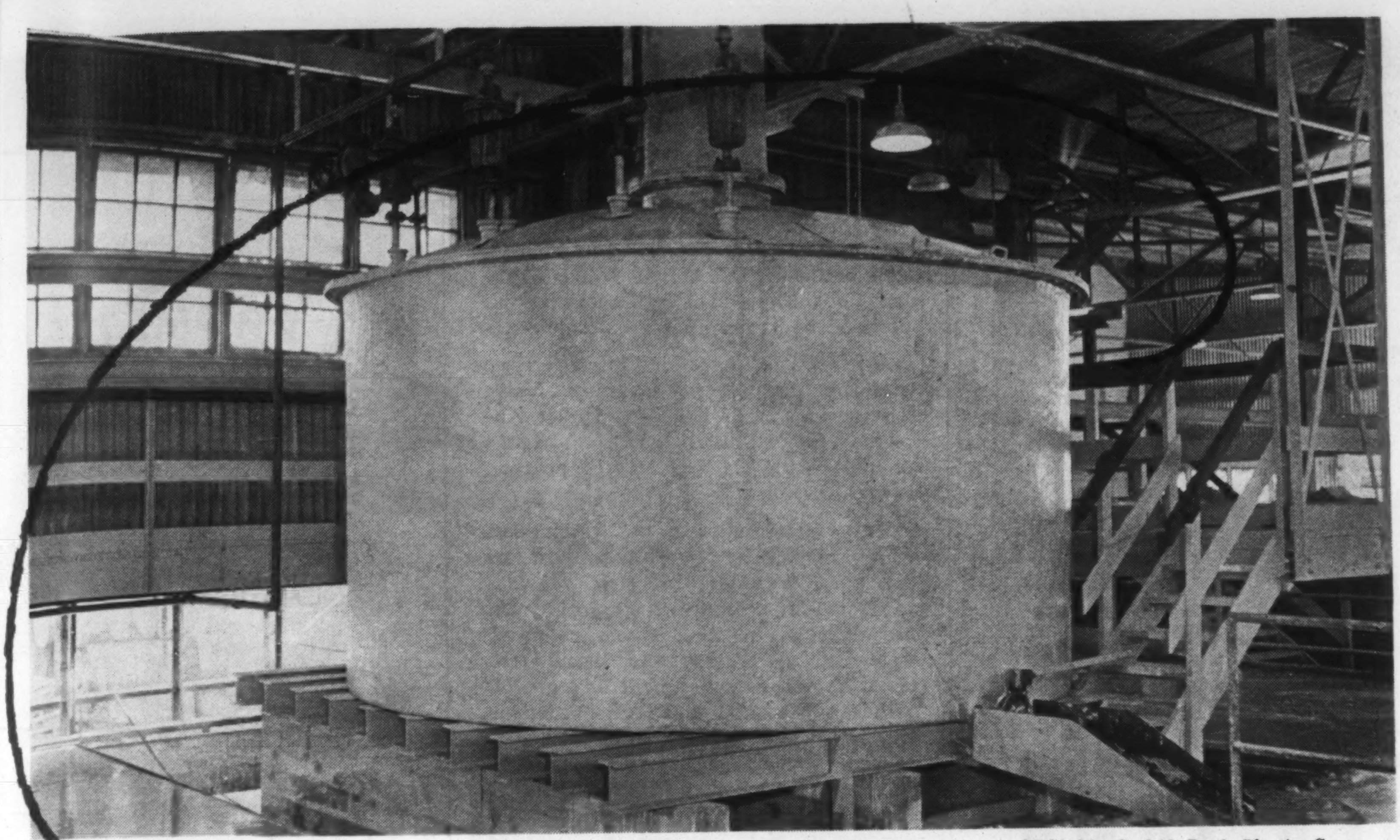
Carl E. Johnson, a veteran of 19 years' service as engineer at Scaife Co., has been appointed chief engineer. *James S. Shuster* was appointed product engineer.

The following appointments have been announced by Salem-Brosius, Inc.: *Frank E. Myers,* vice president of operations, will be in charge of operations; *Thomas E. Lloyd,* formerly assistant to the president, has been named manager of sales; *Carl J. Westling* has been appointed chief engineer; *Walter H. Scheib* has been named manager of foreign operations; *John R. Wickwire* has been named assistant to the vice president, operations; *S. T. Morgan* has been appointed manager of operations.

Five major changes in the top management of United States Steel were recently announced: *Clifford F. Hood* was elected president of the corporation and a member of the board. He also becomes a member of the Finance Committee; *Benjamin F. Fairless* continues as chairman of the board and chief executive officer; *Robert C. Tyson* was elected vice chairman of the Finance Committee and a member of the board, he will also continue as comptroller; *Harvey B. Jorden* was elected executive vice president—operations; *Walter F. Munford* was appointed president of the American Steel & Wire Div.; *Howard E. Isham* was elected vice president and treasurer of the corporation succeeding *Max D. Howell,* who is retiring. Other appointments announced by the company are: *Floyd A. Garman* has been named chief engineer and *Walter V. Magee,* assistant chief engineer of American Steel and Wire Div. Mr. Garman succeeds *Harry L. Jenter,* who was promoted to assistant manager of operations of the Cleveland district.

The board of directors of American Locomotive Co. elected *Perry T. Egbert* president, and *William S. Morris* executive vice president at a special meeting.

Philip H. Kreuscher has joined Tube



Molded by Carl N. Beetle Plastics Corp.

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TAMED BY UNLINED EVAPORATOR TANK ONLY 3/8 INCHES THICK

LAMINAC® Resin 4119 takes boiling alum at pH 3!

Needed: An evaporator tank with exceptional chemical resistance to stand up under the corrosive attack of 4,000 gallons of aluminum sulphate liquor boiling at 240°F, acidity of pH 3. Former steel tanks, double-lined with lead and acid-resistant brick, were *still* subject to corrosion and consequent product contamination.

Chosen: LAMINAC polyester resin 4119, reinforced with Fiberglas* mat, for its outstanding chemical resistance, great strength for weight, easy molding, excellent heat resistance, high dimensional stability.

Success: A corrosion-resistant tank that was easily molded—*linings unnecessary.* Cost, less than half the price of a conventional evaporator; weight, 2,200 lbs.—only one sixth as heavy as a metal tank. What an efficient and economical answer for various types of chemical processing equipment and containers!

Specifications: Height—8′; Diameter—14.5′; Side wall thickness—3/8″; Bottom thickness—1/2″; Cover thickness—1/4″; Stack diameter—30″; Stack height—22′.

*Trade-mark of Owens-Corning Fiberglas Corp.

✓ **REMEMBER . . .** Only in the large family of LAMINAC polyester resins will you find precisely the combination of service properties you need *in superior degree.* While chemical applications for this versatile group of polyester resins are just beginning to be developed, our staff of conveniently located Field Engineers will be glad to help you determine whether there is a LAMINAC Resin that can handle your corrosion problem.

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RESIN-BONDED FIBERGLAS®

This modern material is offered as **pipe** from 2" to 12", **duct** from 6" to 36", **sheets** 4' x 8' for general fabrication, **tanks** from 1/2 to several thousand gallons, **linings** for steel, cement or wood tanks and special moulded shapes for many purposes.

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material resists attack by most acids, solvents, mild alkalis and a wide range of fumes. Withstands temperatures of at least 250°F. It may solve your corrosion problem!

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THE Chemical CORPORATION
67 Waltham Avenue, Springfield 9, Mass.

News Digest

Reducing Corp. as divisional engineer.

Appointment of *A. T. Nelson* as manager of the big M and M Wood Working Co.'s Plywood Div., embracing all plywood operations, has been announced.

William T. Stephens, formerly vice president and general manager, Valve Service Co., has joined The Parker Appliance Co. as staff engineer in charge of the company's development program of industrial hydraulic equipment.

At a recent meeting, the stockholders of Whitney Chain Co. elected a board of directors, including several previous directors and a group of new names. At the directors' meeting which followed, *Richard F. V. Stanton* was elected president. As the new president and general manager, Mr. Stanton will be active on the board and will also serve as the company's chief executive officer of both Whitney Chain and the Hanson-Whitney Divs. Mr. Stanton recently resigned his position as vice president in charge of manufacturing at American Machine & Foundry Co.

Frank W. Egan & Co. has announced the appointment of *W. H. Willert* to its technical staff. Mr. Willert will handle the development of plastics extruding and processing equipment.

S. S. Battles, a vice president of Admiral Corp. and a vice president and general manager of the Midwest Manufacturing Corp., Admiral subsidiary in Galesburg, Ill., has resigned both posts due to ill health.

James L. Myers, president of the newly-formed Clevite Corp., has announced that *William G. Laffer* has been named president of the Cleveland Graphite Bronze Co., Clevite's largest operating unit. *Edwin Crankshaw* was named as Cleveland Graphite's chief engineer and head of the Engineering Div., to succeed *Henry W. Luetkemeyer* who moves to the staff of Clevite Corp. as one of the key men in the new products division.

Ernest W. Marchand has become vice president in charge of operations of the Evans Products Co.

Jack O. Abney is the new associate works manager for the Penn Metal Co. Mr. Abney will be in charge of research and development at the firm's Parkersburg, W. Va., plant.

Dr. Max E. Bretschger, formerly vice president of Buffalo Electro-Chemical Co., Inc., has been elected president of the company to fill the vacancy created by the death of the late *Charles A. Buerk.* Also announced was the election of *Frederick A. Gilbert,* formerly manager of BECCO's Vancouver, Wash., plant, to the position of vice president.

The Farrand Optical Co., Inc., has announced the appointment of *R. A. Hamil-*

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Where the Going
Is Tough!

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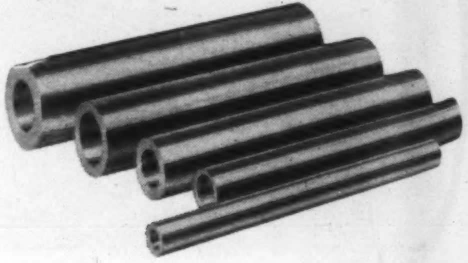
THE Engineered BRONZE

CORED & SOLID
BRONZE BAR STOCK



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Promet's High Safety Factor is Your Insurance Against Bearing Failure!

Tougher, harder and stronger, it resists shock loads and withstands high compressive forces and will not cut, or stick to the shaft under ordinary operating conditions. There is no seizing, no scoring—just smooth, quiet operation. Will not powder under the most severe conditions or service. When lubrication fails temporarily, Promet carries on safely until proper lubrication can be restored, affording protection against production shutdowns.

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It's a tough one to machine

Trip Plate for high speed industrial sewing machine material: Alloy Steel, SAE 8620 Overall length 2½".

but comes out right as a Precision Investment Casting

The machining time required to produce such parts as above illustrated often makes complete costly re-designing of functional parts necessary.

Not so with EpCo precision investment castings because all of these "tough to machine" features are cast with ease and economy.

Often re-designing by EpCo, where permissible, can make these castings even more economical, too—but the close tolerances and the little or no machine finishing required, when you specify EpCo castings, makes it good business to investigate this means of producing your delicate and difficult parts in practically any metal.

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News Digest

ton as consulting engineer in the Optical Tooling Div.

Appointment of *Edgar Schmued,* one of America's foremost aircraft designers, as vice president in charge of engineering of Northrop Aircraft, Inc., has been announced.

J. H. Bruun has joined Hooker Electrochemical Co. as director of research.

The appointments of *Richard D. Tyler* as manager of marketing and *Thomas J. Kelly* as manager of engineering for the General Electric Co.'s Appliance Control Dept. have been announced. Two appointments in the company's Control Dept. at Schenectady have also been announced: *Frederick H. Holt* has been named manager of marketing and *James W. Cooke,* manager of engineering.

American Locomotive Co. has announced the death of *Kendall B. Rowell,* chief engineer.

News of Companies

International Powder Metallurgy Co. has announced completion of its expansion program.

Stockholders of *The Cleveland Graphite Bronze Co.* in a special meeting recently approved the proposal to change the company name to *Clevite Corp.*

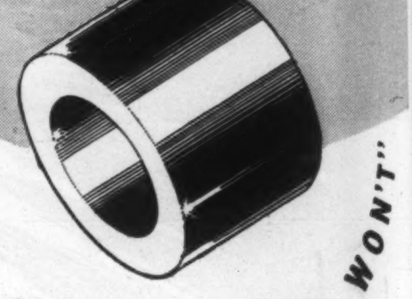
Snyder Chemical Corp. has announced the expansion of its technical service to include a special department for beater addition research with particular emphasis on phenolic resin-elastomer co-precipitations.

Opening of the Union, N. J., plant of *Airco Equipment Manufacturing Div.* of *Air Reduction Co., Inc.* has been announced. The new facility will manufacture welding and cutting torches, tips, regulators, oxygen and acetylene manufacturing and distributing equipment, gas-arc welding apparatus and oxyacetylene cutting machines.

Lindberg Steel Treating Co. has expanded its Los Angeles facilities with the formal opening of a new plant located at 2910 Sunol Drive.

Du Pont Co. has announced that it will start construction early next year on a plant south of Circleville, Ohio, for the manufacture of Mylar polyester film.

Hanson-Van Winkle-Munning Co. has announced the sponsorship of a graduate fellowship as part of its continuing long-



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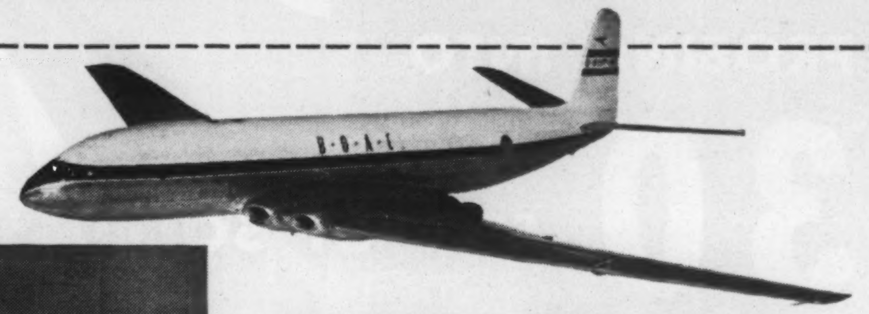
IDEAS

in the making

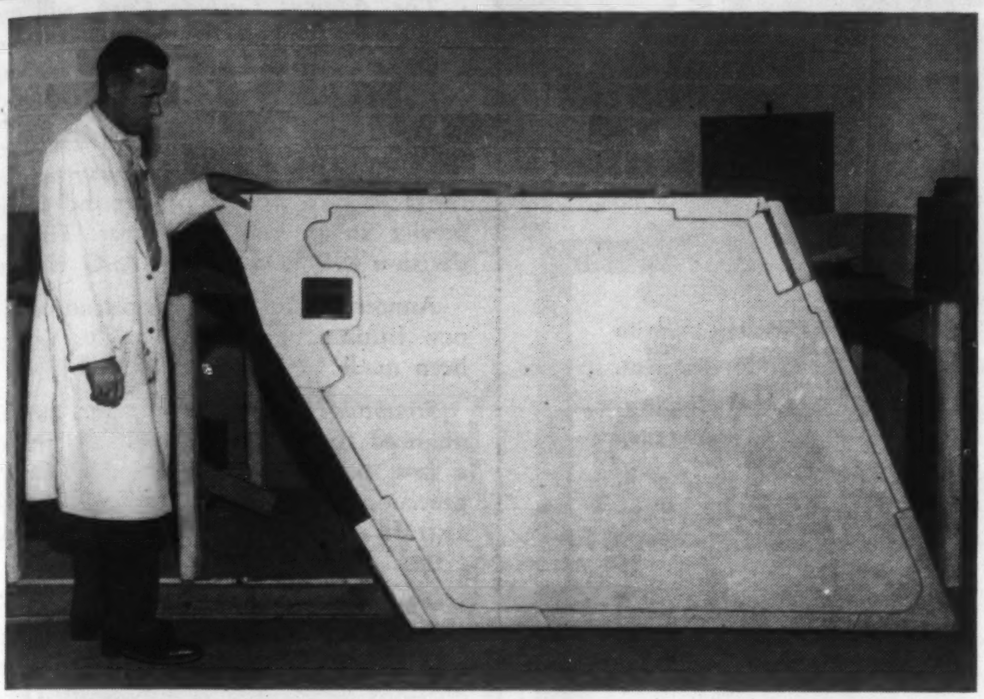
Bonding, Casting and Coating Resins developed by Ciba Research are simplifying manufacturing methods, improving product efficiency, and opening new fields of product development. You will want to know more about them.



OPENING A NEW ERA IN AIRCRAFT ENGINEERING

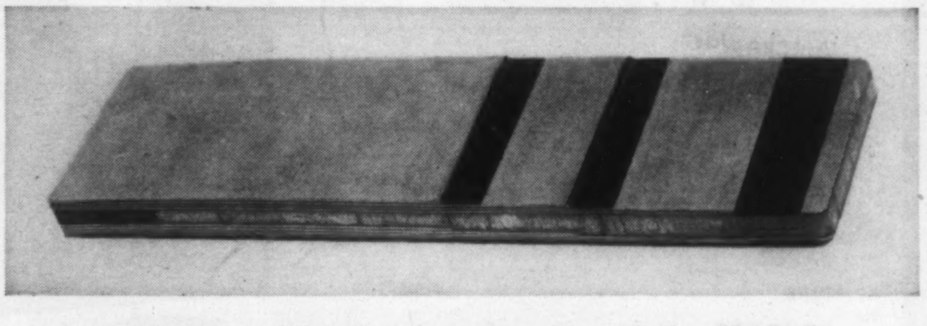
REDUX

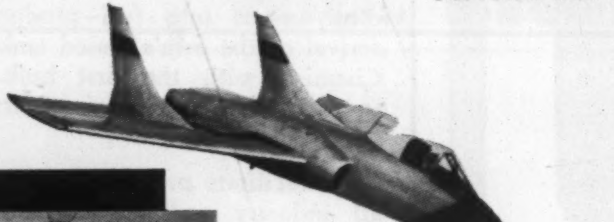
The Redux Bonding Process, developed by Ciba's subsidiary, Aero Research in England, makes possible the rivetless assembly of primary structures in aircraft. The famed de Havilland "Comet" shown above was specifically designed to use the Redux Process in the assembly of its components, and was built directly from the drawing boards without a prototype. The acceptance of the Redux Bonding Process by the aircraft industry has been demonstrated further by its adoption as standard procedure in military types as well, such as the U. S. Navy's "Cutlass" jet fighter built by Chance-Vought.*



Shown above is a single curved wing panel used as a primary structure in a high performance Chance-Vought Aircraft jet. This type of construction is typical of Redux-bonded assemblies comprising metal-to-metal and metal to end-grain wood adhesive bonds.

Shown below is a section of a typical sandwich construction utilizing thick facings and end-grain wood core, bonded together with a structural adhesive. The internal doubler at the right illustrates how local reinforcements may be added and still retain flush contour.





The achievement of ways and means to assemble aircraft components with the "Redux" Process as developed by Dr. N. A. de Bruyne, Ciba's distinguished associate from England, has won widespread engineering and public attention both here and abroad.

In response to long-standing invitations from American universities, engineering societies and aircraft companies, Dr. de Bruyne is now filling a specially arranged lecture itinerary to appear before these groups from coast to coast.

➡ REPRINTS OF PUBLISHED PAPERS BY DR. DE BRUYNE ON THE "REDUX" PROCESS and related data sheets have been assembled in a special reference file folder to serve as a preliminary guide to aircraft engineers in evaluating and using the "Redux" bonding process. Complete engineering assistance and information on the use of the process are available from Ciba.

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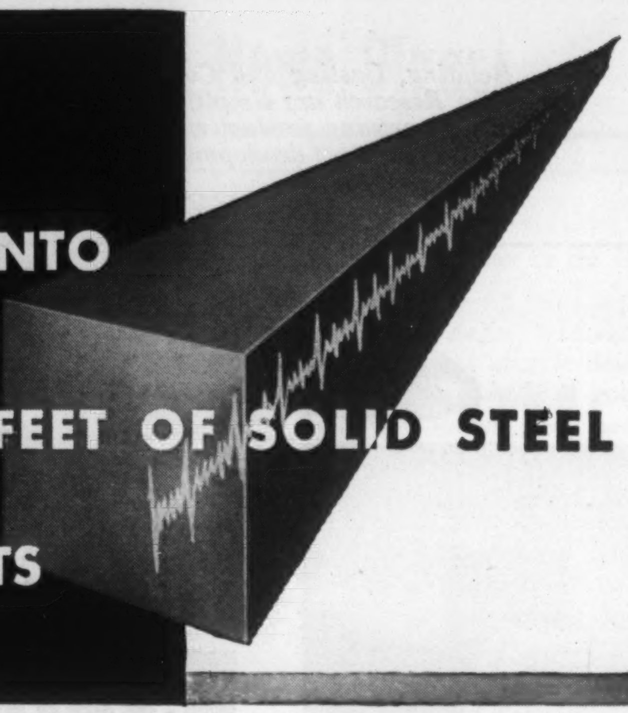

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OFFERS THESE COST SAVING ADVANTAGES

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News Digest

range policy of promoting the study of fundamental research in electroplating and allied fields. Joseph M. Tobin is the new fellow, elected by the faculty at Michigan State College. He will study the "Diffusion Rates of Gases Through Metal Films."

The Adamas Carbide Corp. will construct a new plant for the production of tungsten carbide tool tips, dies, wear parts and powder in Kenilworth, N. J.

Arthur D. Little, Inc. has announced the establishment of an *International Div.* to meet the increasing demand for its service in international areas. The new division will be headed by A. G. Haldane.

Announcement of the construction of a new lithium plant at Sunbright, Va., has been made by *Foote Mineral Co.*

Simmonds Aerocessories, Inc. has announced that construction has started on a new plant in Vergennes, Va., for the precision manufacture of high priority aircraft electronic and mechanical equipment.

Announcement has been made by *Delanium Carbon Corp.* that its new factory at Morton Grove, Ill., is now in production. The plant is producing Delanium graphite cubic heat exchangers.

Synthane Corp. has added a two-story wing to its plant at Oaks, Pa.

The new plastics plant of *The Dow Chemical Co.* at Allyn's Point, Conn., recently went into full production upon arrival of the firm's leased tanker, Marine Chemist, with the first bulk cargo of styrene monomer ever transported by ocean-going vessel.

To facilitate production and delivery to all industry and jobber distributors of cold finished steel, *Sierra Drawn Steel* Corp. has established a mill in Seattle capable of handling cold finished bars from 1½ to 6 in.

Directors of *National Malleable and Steel Castings Co.* have approved a $2,000,000 expansion of its *Capitol Foundry Co.* facilities near Phoenix, Ariz.

According to a recent announcement, *Pyramid Mouldings Inc.* of Chicago has merged with the firm of *Western Mouldings & Stampings, Inc.* of Ontario, Calif. I. L. Reed, president of the parent company, announced that their new subsidiary has been renamed *Western Mouldings, Inc.*, division of Pyramid Mouldings, Inc.

The Goodyear Tire & Rubber Co. has announced plans for a $1,500,000 expansion program for its Chemical Div.

Heli-Coil Corp. has announced the 1952 Heli-Coil Engineering Student Design Award Program. The program is open to resident engineering undergraduate students registered in any school, college or university in the United States and Canada which offers a curriculum in

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Tool steel is our baby. It has been for 52 years. It always will be. That's why tool steel users look with confidence to Crucible.

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Why is this possible? Because Testing is our Business. Your tests will be handled by men who live, breathe, and think testing. They will receive the care and attention that only a specialized laboratory can give them. That means speed, accuracy, and real economy.

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News Digest

any branch of engineering leading to a degree. Cash awards will be made for the most original or unique new uses for Heli-Coil thread inserts as follows: First Award—$1000; Second Award—$500; Third Award—$250; Merit Awards—$100.

Consolidated Industries, Inc. has completed installation of new aging furnaces that are expected to increase by 100% the capacity of the plant to heat treat aluminum forgings.

Coincident with the completion of *Permutit's* 1952 expansion program for doubling the capacity of the Birmingham, N. J., works for the production of ion exchange resins, the company has now placed contracts for further extensions and improvements, including a new laboratory and pilot plant building.

Atwood Vacuum Machine Co. recently celebrated completion of its new plant at Rockford, Ill., with open house ceremonies. The new plant will manufacture stamped and machined parts.

Start of construction of a new plant in Sharonville, Ohio has been announced by *Cincinnati Cleaning & Finishing Machinery Co.* The new plant is expected to be completed some time after the first of the year.

Research and development will play an increasingly important role in *Dravo Corp.*'s activities during 1953. Through the formation of a new department, all research functions of the corporation and its associated interests are now consolidated at Neville Island, where laboratory facilities are now under construction.

New rules have been announced for the $2000 prize competition for "Contributions to the Science and Art of Non-Fusion Welding, Brazing and Soldering" by *Eutectic Alloys Corp.* A complete set of contest rules, together with other pertinent data, can be obtained by writing to Eutectic, Dept. P, 172nd St. and Northern Blvd., Flushing, N. Y.

Steel City Testing Machines, Inc. has moved to a new and more extensive plant at 8817 Lyndon Ave., Detroit 21.

The Luria Engineering Co. is erecting a 16,575 sq. ft. addition to its factory of San-Equip, Inc.

Westinghouse Electric Corp. has announced that it will construct an ultramodern plant for the manufacture of welding electrodes and brazing alloys near Montevallo, Ala.

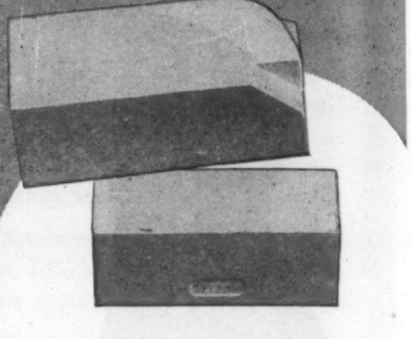
Park Chemical Co. has acquired new manufacturing and warehousing facilities at 3031 Melvale St., Philadelphia.

Maysteel Products, Inc. has announced the organization of a subsidiary to be known as *Gleason Reel Corp.* The new company will manufacture and distribute the Gleason industrial reels as produced

McDANEL

HIGH
DENSITY PORCELAIN

- MILL LINING
- SPECIAL SHAPES
- TANK LINING



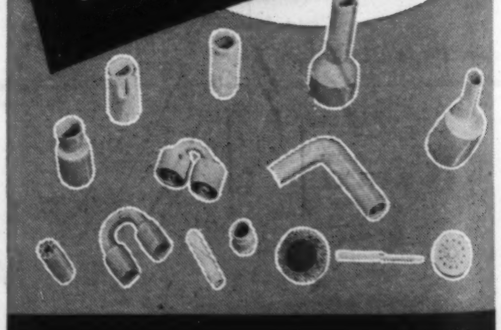
McDanel High Density Mill Lining in routine production grinding in Mills of various sizes shows better than two times longer service over the regular porcelain brick. This high density lining brick—for all types of ball mill grinding—comes in a complete range of sizes to fit every size mill.

Porcelain Specialties

McDanel is equipped to design and manufacture porcelain specialties to meet your individual requirements, quickly and efficiently. We will be glad to help you solve your problems.

Write for "Industrial Porcelain" catalog

HIGH TEMPERATURE PORCELAIN SPECIALTIES



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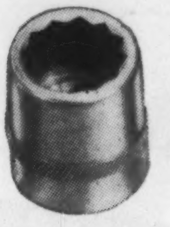
BEAVER FALLS, PENNSYLVANIA



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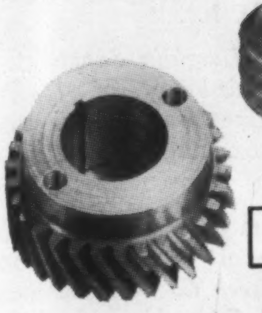
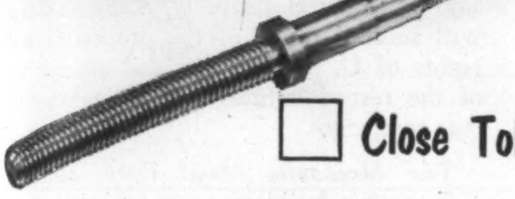
☐ **Fine Surface**

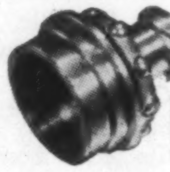
☐ **Toughness**



☐ **Hardenability**



☐ **Close Tolerance**



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WHAT ARE YOUR REQUIREMENTS?

Republic Cold Drawn Alloy Bars deliver all 6 . . . plus

UNIFORM MACHINABILITY

Check the properties your steel parts require . . . add the economy of uniform machinability . . . and you have the answer to production and cost problems . . . Republic Cold Drawn Alloy Steel Bars.

High-speed automatics take full advantage of the cost-cutting qualities of Republic Bars. Designers can make full use of the high strength and uniform structure of these cold drawn bars. Production men can get the ideal combination of wearability and strength out of the uniform hardenability and toughness of the alloy steel.

And . . . Republic 3-Dimension Metallurgical Service focuses the experience of our Field, Mill, and Laboratory metallurgists on your production problems for the best answer with Republic Cold Drawn Alloy Steel Bars.

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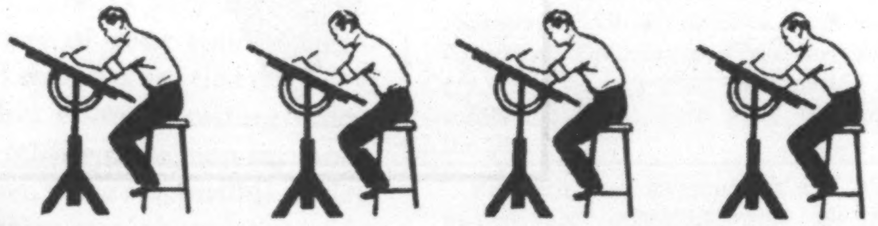
ALLOY STEEL BARS

Handles anything up to 12 feet!

This Office Typist is doing the work of 4 Draftsmen...



This girl (who doesn't have and doesn't need, an engineering degree) is daily saving her firm the lettering time of 4 draftsmen. And she's doing a neater, sharper, more legible job of lettering, too!

EASY AS ABC to operate! Standard keyboard works like a typewriter. Wide selection of instantly changeable type faces makes Vari-Typer useful and MONEY-SAVING for other jobs.. setting text type for specification sheets, literature, instruction manuals, etc... which can be duplicated on office machines or offset printing.

Vari-Typer Lettering Machine

Body copy produced on DSJ Model.
Headlines photo-composed on the Headliner.

SEND THIS COUPON
...and learn how you too can break that drafting room bottleneck.

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News Digest

for over 35 years by *J. L. Gleason & Co., Inc.*

The name of *Calumet and Hecla Consolidated Copper Co.* has been changed to *Calumet & Hecla, Inc.*

The Jones & Laughlin Supply Co., a wholly-owned subsidiary of *Jones & Laughlin Steel Corp.*, will become a division of J&L, according to a recent announcement.

In the program of simplifying the corporate structure of *United States Steel, United States Steel Co.* will be merged into U. S. Steel Corp. U. S. Steel Corp. will succeed to all of the properties and rights of U. S. Steel Co. and assume all of the responsibilities and obligations of that company.

The Meehanite Metal Corp. recently purchased a building at 714 North Avenue, New Rochelle, N. Y. and is now installed in these new headquarters.

TOCCO Induction Heating Div., Ohio Crankshaft Co., has announced the winners of its 1952 "Economy in Production" contest. Winner of the first prize of $1000 was Lloyd E. Raymond, metallurgist, Singer Manufacturing Co.

A plan for the acquisition of the assets and business operations of *Doebler-Jarvis Corp.* by *National Lead Co.* has been announced. The business will be operated as a division of National Lead. The transaction is awaiting final approval.

The General Electric Co.'s J-47 jet engine manufacturing plant near Cincinnati will be officially known now as the *Evendale Plant,* after operating for more than four years as the *Lockland Plant.*

A major plant expansion program has been completed by *Bloom Engineering Co.* The expansion gives the company a substantial increase in production facilities, an improved test laboratory, more office space and a 100% increase in assembly and storage area.

Rust Engineering Co. has established a scholarship fund at Lehigh University with a gift of $25,000. The income from this fund is to be used for one or more students in engineering.

In a move designed to meet a constantly growing demand on the West Coast, *American Cyanamid Co.* recently expanded production facilities at its Azusa, Calif., plant to include Laminac resins.

Electro Devices, Inc. has recently acquired the electronic motor speed interests of *Servo-Tek Products Co.*, and will expand the line of Servospeed control systems under its newly formed *Servospeed Div.* The division has acquired a two-story brick building at 4-6 Godwin Ave., Paterson, N. J.

The establishment of a new *Yale Lock and Hardware Div.* to coordinate greatly

BUY NO RUBBER PARTS

until you've investigated

G-E SILICONE RUBBER!

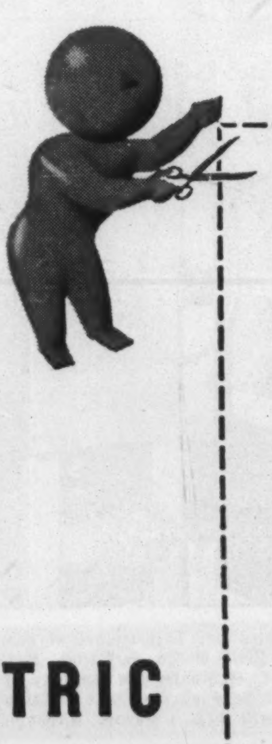
In the market for rubber parts? Then you'll want to investigate the amazing advantages of General Electric silicone rubber before you buy or specify. Designers find G-E silicone rubber solves problems where conventional rubber fails . . . that it does jobs *no other* rubber can do!

For example, G-E silicone rubber remains flexible from −100 to 500 F and has unusual resistance to weather and chemical attack. This means long-lasting rubber parts for applications heretofore impractical with ordinary elastomers. It means:

- **Increased safety factor**—vital to aircraft
- **Less replacement cost**
- **Less rubber parts inventory**
- **A minimum of customer complaints** due to failure of conventional rubber

And . . . G-E silicone rubber can add important "sales pluses" to your product lines!

Get more information! Why not send today for a free booklet, "Imagineering with Silicone Rubber"? It describes the amazing properties of this material and its applications. Find out how G-E silicone rubber—now three times stronger than early varieties and available in many new forms—is more useful than ever. Just mail the coupon.



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Imagineering
WITH
SILICONE
RUBBER

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Waterford, New York

Please send me, free, your new booklet "Imagineering with Silicone Rubber." I am interested in G-E silicone rubber for:

( ) Seals and gaskets
( ) Wire and cable insulation
( ) Tapes and cloths
( ) Sponged products
( ) Belting
( ) Boots, sleeves. bellows
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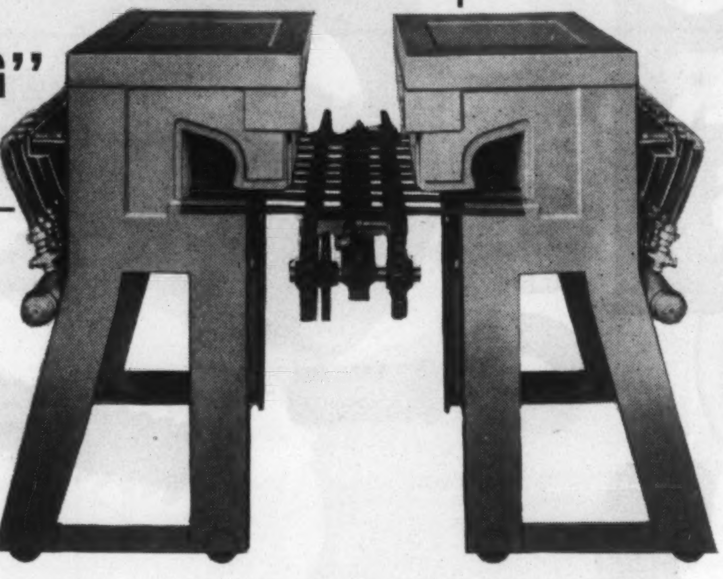
G-E silicones fit in your future

GENERAL ELECTRIC

Twin ROTO-FLAME FURNACES QUADRUPLE "END HEATING" PRODUCTION

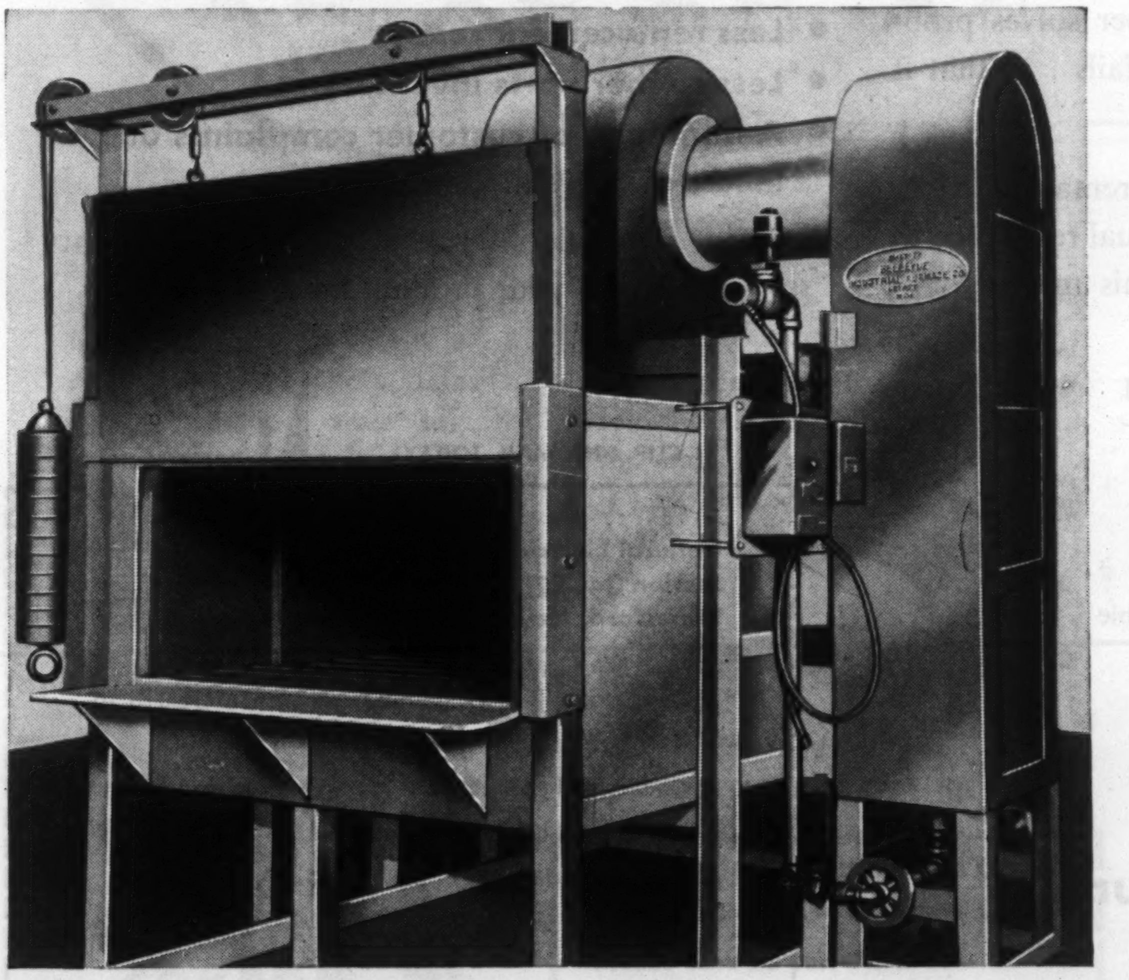


Exclusive (High-Speed) Roto-Flame Design Cuts Heating Time in Half

The above installation shows how a leading automotive spring maker revolutionized spring leaf production in his plant by using 2 units . . . thus heating both ends of flat bar stock simultaneously before swaging (or eye-curling) operation.

Boosts Production—through much faster heating . . . uniform control . . . uniform temperature.
Cuts Operating Costs—Operation can be made fully automatic . . . saves fuel . . . saves labor . . . saves 75% floor space . . . prolongs die life.
Provides Better Working Conditions—Heat concentrated on work . . . not on operator. Utilizes any type of gas fuel.
New Savings in Heating—for forging, swaging, upsetting, threading, hardening, or annealing. Ask for Bulletin No. 350.

GAS APPLIANCE SERVICE, INC.
Industrial Gas Engineers
1213 WEBSTER AVENUE • CHICAGO 14, ILLINOIS



Batch type furnace for the heat treating of aluminum alloys—consists of atmosphere type burner mounted on the lower end of the combination chamber to reheat the recirculated hot air through the furnace. A High Heat insulated recirculating fan is standard equipment for recirculating the heated air. This method of heating holds temperature with little or no variation. Mounting the burner in the duct, eliminates the necessity of an extra heating unit. . . . Send us your heat treating problems . . . our engineers will make a proposal without obligation.

BELLEVUE INDUSTRIAL FURNACE COMPANY
2626 Crane **Est. 1910** **Detroit 14, Michigan**

News Digest

expanded operations of the *Yale & Towne Manufacturing Co.* has been announced. The new division unifies under one management the manufacture and sales in the United States of the company's plants producing Yale brand locks and hardware at Stamford, Conn.; Salem, Va.; and two new plants now under construction.

The need for expanded manufacturing facilities and substantially increased plant area necessitated the recent relocation of *Industrial Washing Machine Corp.* to a new site at 32 Main St., Matawan, N. J.

A wholly-owned subsidiary of *The Colorado Fuel and Iron Corp.* has contracted to buy all of the manufacturing business, plants and inventories of *John A. Roebling's Sons Co.*

Bassons Industries Corp. are adding a 15,000-sq.-ft. expansion to its plant.

Smoothex, Inc. has announced completion of its new modern plant at 10705 Briggs Rd., Cleveland 11.

W. S. Shamban & Co. is constructing a building at 11617 W. Jefferson Blvd., Culver City, Calif., that is expected to increase its capacity by 300%.

Opening of Canada's first refinery for the production of pure tungsten carbide directly from tungsten ores has been announced by *Kennametal Inc.* The company's new Canadian works is known as *Macro Div.* of Kennametal Inc. It is located at Port Coquitlam, British Columbia.

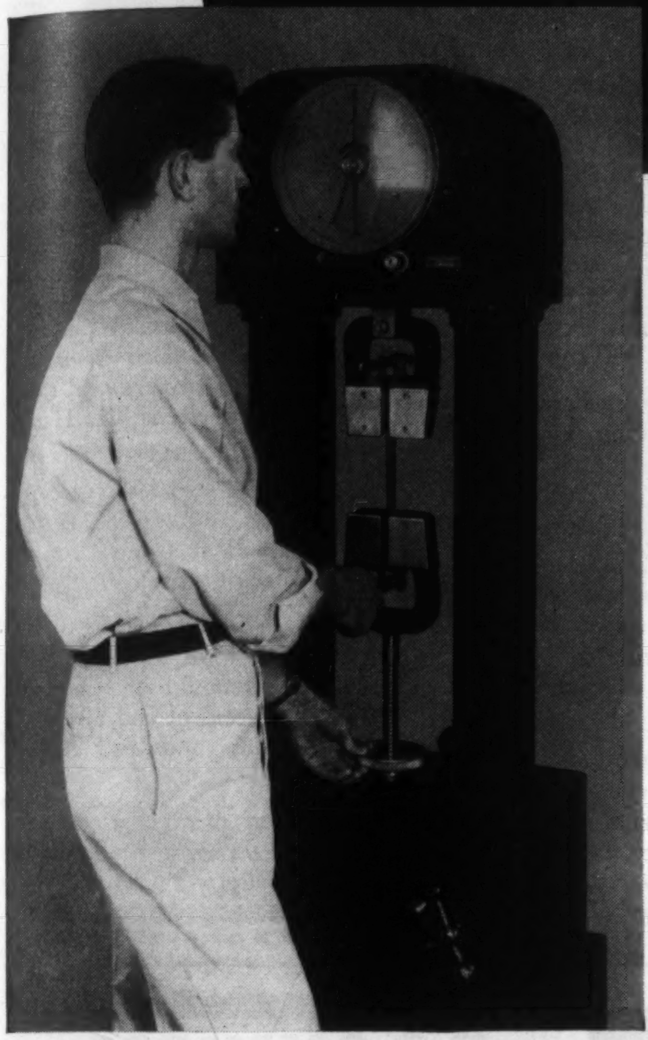
In order to serve clients and customers in a more efficient manner, *Bacon Laboratories* has announced the organization of *Bacon Industries, Inc.* to produce O-rings, gaskets and similar specialty products formerly manufactured by the Frederick S. Bacon Labs. With manufacturing facilities at 192 Pleasant St., Watertown, Mass., the direction and management of Bacon Industries will remain under the parent organization.

Aluminum Co. of America has announced its plans to build a modern new fabricating plant in the Lancaster, Pa., area for the production of aluminum screw machine products, fasteners, rivets and nails.

News of Societies

A more than 350% increase in scholarship aid to American and Canadian college students studying tool engineering and allied subjects has been voted by the

OLSEN has the *Dependable, Low Cost* LC TESTING MACHINE



. . . for standard tension, compression and transverse tests on metal (strip, spot weld, wire, etc.) plus plywood, bricks, cement, briquettes, textiles, rivets, insulating materials, plastics and many others.

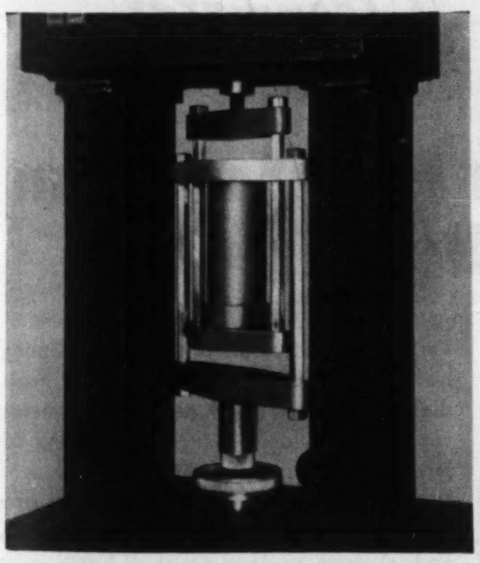
DUAL CAPACITIES 10,000 and 1,000 lb. testing ranges.

ACCURACY to within ±1% of the indicated load or ±1 dial division, whichever is the greater.

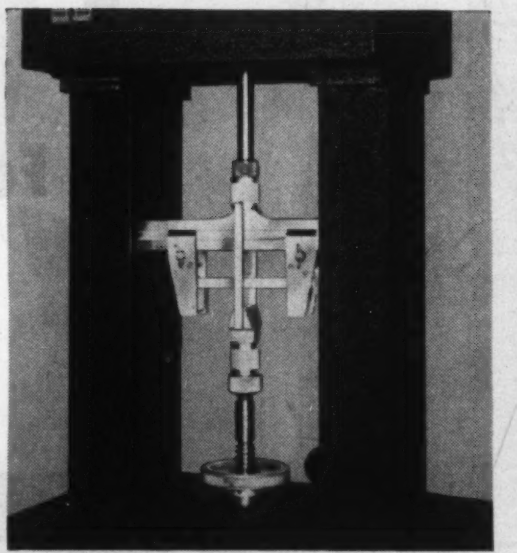
PENDULEVER WEIGHING SYSTEM—pendulum and lever—completely independent of the loading system.

MOTOR DRIVEN OR HAND OPERATED—either model gives assurance of dependable testing service with a minimum capital investment.

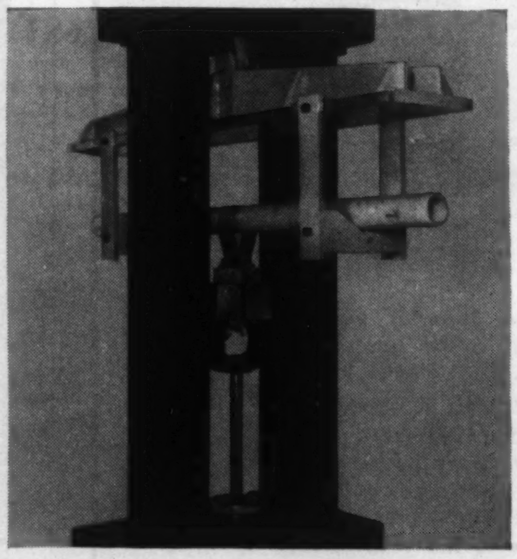
CONVENIENCE—Tools for all types of testing can be inserted quickly and easily, and all controls are readily accessible.



Compression Testing with an LC.



Flexure Testing with an LC.



LC being used to test transite pipe.

LC IS IDEAL FOR PRODUCTION TESTING, QUALITY CONTROL OR INSTRUCTION.
The Olsen LC answers the needs of industry and educational institutions for a modern, compact and low cost testing machine which can be used for a wide variety of testing problems.

write for Bulletin 41 today

TINIUS OLSEN
Testing & Balancing Machines

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2010 Easton Rd., Willow Grove, Pa.

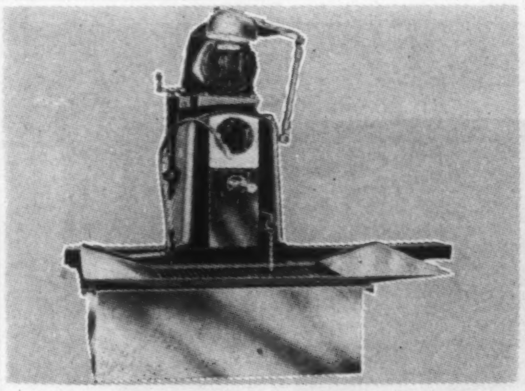
The Answer to YOUR HONING PROBLEMS

Here's why they're switching to the

SUPERIOR HONING MACHINE

Model "J"

There IS a difference in honing machines. Superior gives you all the features you want. It's the most versatile and economical bench type honing machine made. For instance, how many spindle speeds would you like? The Superior gives you infinitely variable speeds from 400 to 1000 r.p.m. AND without changing belts. Talk about ease and speed of changing mandrels and stones—no tools are needed! All stones are ground to size.



With the Superior you can hone over keyways, spline gears and most broken surfaces. How big is it? 13" x 16½" x 25" high. It weighs only 125 pounds.

Use a Superior honing machine. You'll be quick to see its many advantages and will be satisfied with no other, for after all arguments are exhausted, performance is the test.

Use coupon today to get free literature.

SUPERIOR HONE CORPORATION
1606 Elreno Street
Elkhart, Indiana

Please send free catalog on Superior Honing Machines.

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News Digest

board of directors, *American Society of Tool Engineers.* For 1953, the Society is offering ten $700 scholarships to college students in their fourth or fifth year who are taking subjects coming under the general category of tool engineering. Applications for the scholarships must be made before Mar. 1, 1953. Blanks and details can be obtained from Society headquarters at *10700 Puritan Ave., Detroit 21.*

Steel Founders' Society of America has been cited for national recognition as winner of the 1952 Award of Merit conferred by *American Trade Assn.*

Dr. Christopher E. Barthel, Jr. was elected chairman of the board of directors of the *National Electronics Conference* at the recent annual meeting. Starting his fourth year as a member of the NEC board, Dr. Barthel succeeds Kipling Adams of General Radio Co.

A number of industrial research fellowships in physics, chemistry and chemical engineering, metallurgy, ceramics and minerals, engineering mechanics are being offered by *Armour Research Foundation, Illinois Institute of Technology.* The Foundation awarded nine fellowships in 1952, and plans to award about 15 in 1953.

Charles J. McCarthy, vice president, United Aircraft Corp., has been elected president of the *Institute of the Aeronautical Sciences* for 1953.

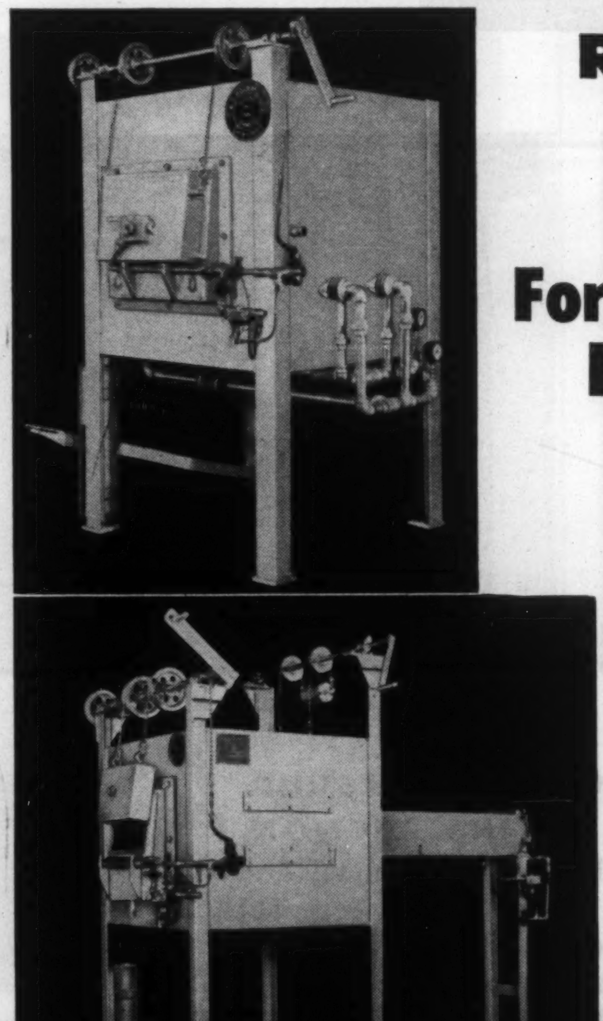
The Association of Consulting Chemists and Chemical Engineers, Inc. has appointed Robert T. Baldwin executive secretary and assistant treasurer, and A. B. Bowers, director of publicity and assistant executive secretary for 1953.

R. C. Sogge, manager of the Standards Dept., Engineering Services Div., General Electric Co., has been elected president of the *United States National Committee of the International Electrotechnical Commission.* Mr. Sogge succeeds Dr. Harold S. Osborne.

Ernest A. Schoefer, formerly executive secretary of the *Alloy Casting Institute,* has been elected to the newly created post of executive vice president.

Roger E. Gay, president, The Bristol Brass Corp., and Edward T. Gushee, vice president, the Detroit Edison Co., have been reelected as president and vice president of the *American Standards Association.*

The presentation of a charter to the *Midwest Research Institute* Branch of the *Scientific Research Society of America* was recently made.



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Kleenmetal
FURNACES

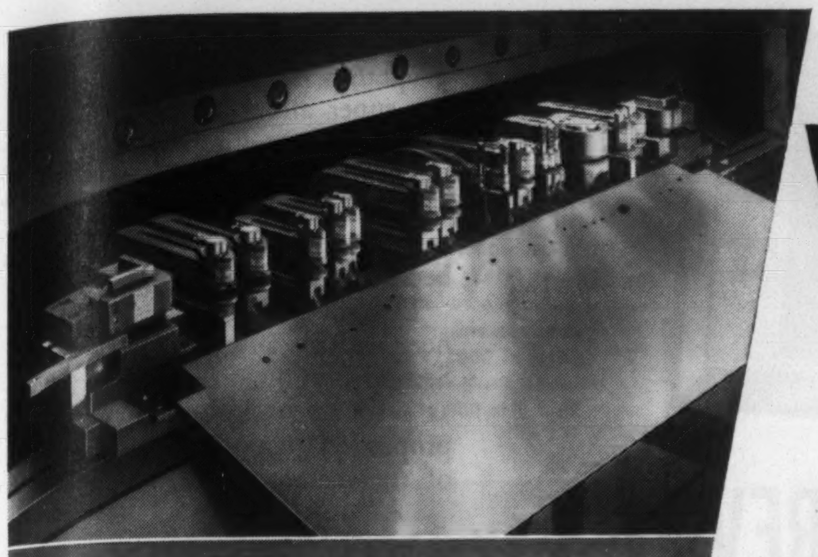
For Bright or Clean Heat Treating

For scale-free, clean or bright annealing, hardening, non-decarb heating of tools, dies, small steel and non-ferrous pieces; copper or silver brazing or sintering, at temperatures up to 2400° F., Kleenmetal Furnaces belong in your shop. They give precisely controlled metallurgical quality and desired surface finish — batch after batch.

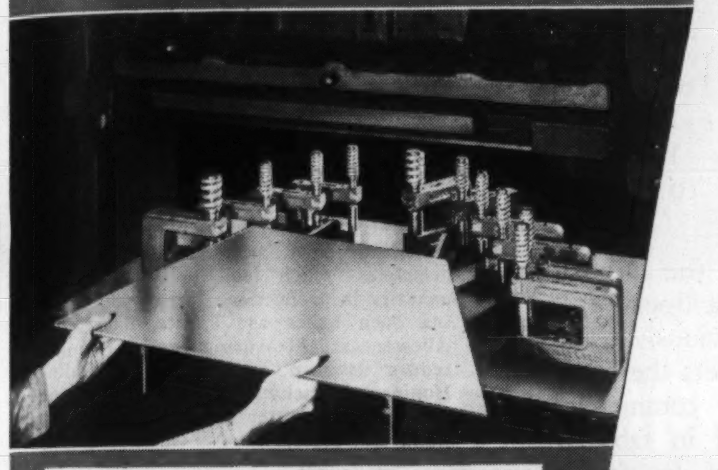
Kleenmetal Furnaces are compact, rugged, efficient, easy and economical to operate. Built in gas, oil or electric types; direct heated or with muffle; with cooling chamber, if desired. Truly ideal for the tool room, experimental or moderate production requirements.

Bulletin No. 435 gives full details. Write for a copy.

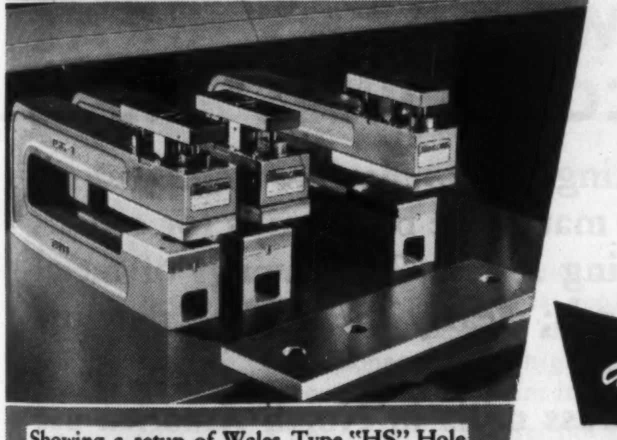
W. S. ROCKWELL COMPANY
2083 ELIOT STREET • FAIRFIELD, CONN.



Showing Wales Type "BL" Hole Punching and Type "N" Notching Units in a combination press brake setup for punching and notching mild steel up to 1/8" THICK.



A stamping press setup of Wales Type "CJ" Hole Punching Units for punching mild steel up to 1/4" THICK.



Showing a setup of Wales Type "HS" Hole Punching Units in a press brake for punching mild steel up to 3/4" THICK.

PUNCHING 1/8", 1/4" AND 3/4" THICK METAL ?

standardize on

WALES

Hole Punching Units

Only Wales Hole Punching and Notching Units provide the numerous *patented features* plus the *time and cost saving advantages* that have made it "standard practice" with thousands of metal fabricators to *standardize* on this *exclusive* equipment.

Wales independent, self-contained Units eliminate costly, single-purpose custom dies, reduce expensive setup time and practically eliminate press "downtime."

The same group of Wales Units may be interchangeably set up in stamping presses and press brakes. In many cases, setups of Wales Units are in production the same day a hole punching pattern is released by your engineering department.

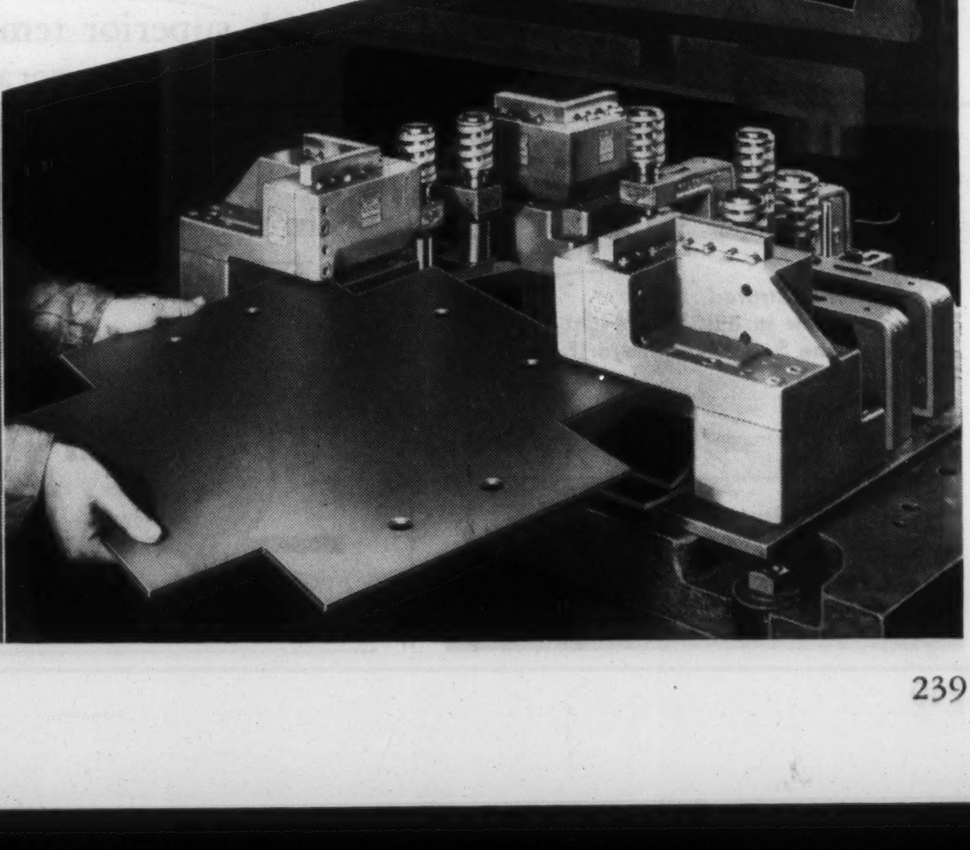
The multiple advantages of Wales Hole Punching and Notching Equipment are too MANY to tell here, so write for fully-illustrated, functionally colored catalogs TODAY.

WALES-STRIPPIT CORPORATION
George F. Wales, *Chairman*
399 Payne Avenue, North Tonawanda, N. Y.
(Between Buffalo and Niagara Falls)
Wales-Strippit of Canada, Ltd., Hamilton, Ontario

Specialists in Punching and Notching Equipment

also notching up to 1/4" thick metal

Showing a setup of Wales Type "NJ" Notching Units in a stamping press for notching mild steel up to 1/4" THICK.



NOW you can
BRIGHT–ANNEAL
STAINLESS
on a continuous
production basis, with
The
SARGEANT & WILBUR
Controlled Atmosphere
CONVEYOR FURNACE

PARTS MADE OF STAINLESS can be

BRIGHT-ANNEALED,
BRIGHT-HARDENED, or
BRIGHT-BRAZED without oxidation . . . they come out scale-free, bright, and clean. No pickling required, no tumbling, no sand blasting.

With our special S. & W. alloy for bright-brazing stainless, the color matches the metal; resists dulling; and the joint is practically invisible. *Gold and silver parts* are *soldered* in the same continuous-production furnace with equal success.

Your samples processed free. If you want to see some of your own work bright-annealed, bright-hardened, or bright-brazed in a conveyor *furnace*, send us samples and specifications.

SARGEANT &
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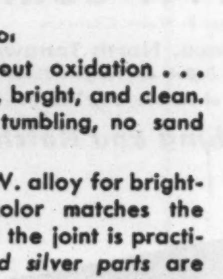

Send your illustrated folder "How to BRIGHT-ANNEAL STAINLESS in the S. & W. Conveyor Furnace."

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Company ....

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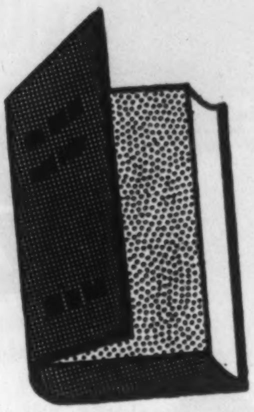
Representatives:
NEW YORK CITY and PENNSYLVANIA Gerald B Duff, 68 Clinton Ave., Newark, N. J.; MICHIGAN and NORTHERN OHIO M. C. Schwer, 2970 W. Grand Blvd., Detroit 2, Mich.; NEW ENGLAND James J. Herkis, 180 Weeden St., Pawtucket, R. I.



BOOK REVIEWS

Data Book

METAL DATA. SECOND EDITION. *By S. L. Hoyt. Published by Reinhold Publishing Corp., New York 36, N. Y., 1952. Cloth 7 x 10 in., 526 pages. Price* $10.00

The second edition of the author's "Metals and Alloys Data Book" follows the form used previously. The bulk of the material covers the engineering properties of commercial metals and is presented in tablular form with a minimum of descriptive text.

New chapters dealing with the properties of heat treated steels and the super alloys are the major additions to the compilation. Reflecting the availability of additional information on both old and new metals, the number of tables and graphs has been almost doubled.

Designed for the materials engineer and metallurgist, "Metal Data", Second Edition, will prove invaluable as a source of information on metal properties for the technical personnel of the metal industry.

Other New Books

TOOL ENGINEERING. *By A. P. Gwiazdowski. Published by C. C. Nelson Publishing Co., Appleton, Wis., 1952. Cloth, 6 by 9 in., 300 pp. Price $4.00.* Based on long years of practical as well as professional experience, the material offered here serves both as a lucid text for the tooling engineering student and as a refresher for veteran tool engineers. The author develops step by step the essential principles which lead to high quality and quantity in production. Twenty chapters covering such topics as: Limits, Tolerances and Allowances; Measuring and Gaging; Procedure used in Tool Design; Grinding and Honing; Broaching; Drilling; Reaming and Tapping are written in simple, easy to understand languages.

(More Reviews on page 242)

HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL

No industry melting ***commensurate tonnage**** of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:

Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field—less than 1%—with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

The accepted melting tool in brass rolling mills throughout the world.

** Upwards of 5 billion pounds annually.*

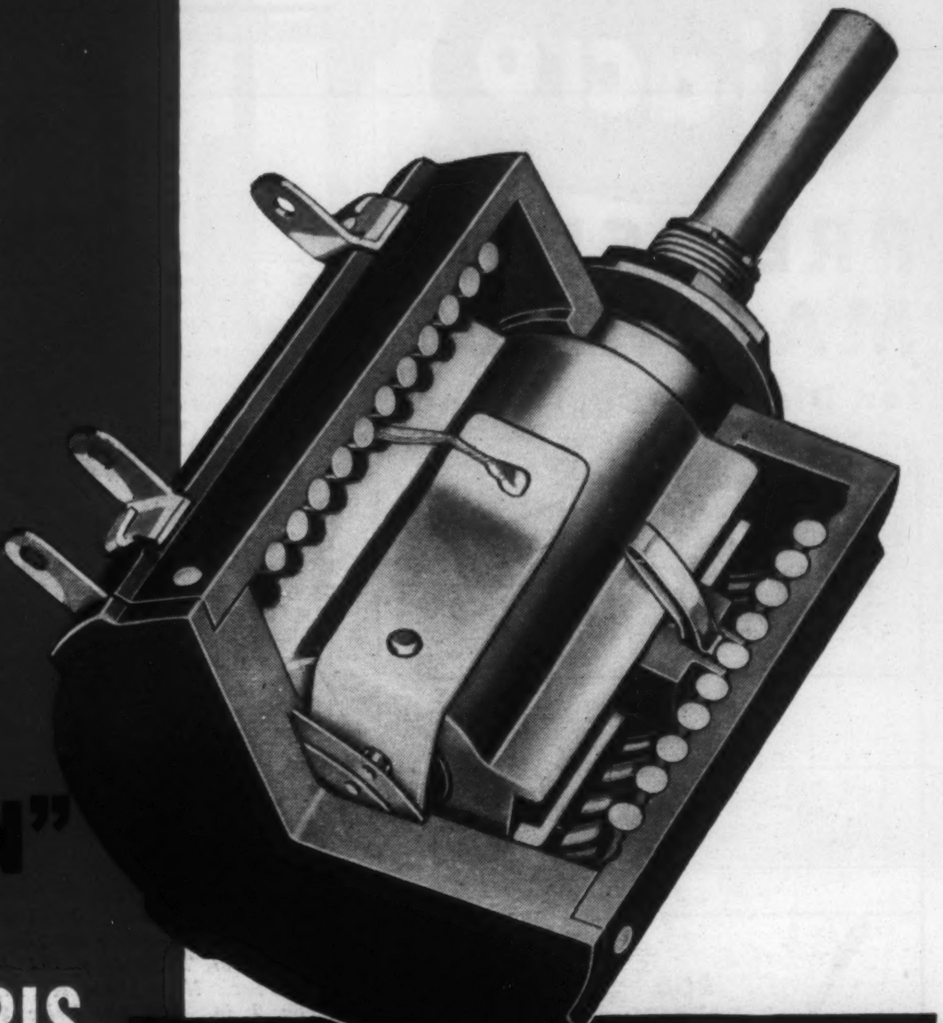
AJAX ELECTRIC FURNACE CORP.
1108 Frankford Avenue • Philadelphia 25, Pa.

THE AJAX WYATT INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES:
AJAX METAL COMPANY, *Non-Ferrous Ingot Metals and Alloys for Foundry Use*
AJAX ELECTROTHERMIC CORPORATION, *Ajax-Northrup High Frequency Induction Furnaces*
AJAX ELECTRIC COMPANY, INC., *The Ajax-Hultgren Electric Salt Bath Furnace*
AJAX ENGINEERING CORPORATION, *Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces*

Series AJ Helipot models are only ¾" in diameter and 1⅜" long; weight 1.0 oz. Ten-turn 18" slide wire gives adjustment accuracy of 1/3000 in a 100-ohm unit—1/6500 in a 50,000-ohm unit.

Helipot achieves "HIGHEST PRECISION" with DRIVER-HARRIS RESISTANCE WIRE



Cutaway view of Model A 10-turn Helipot precision helical potentiometer. Resistance element 45" long is contained in case 2" x 1-13/16" diameter. On element are wound 3000 to 9800 turns of resistance wire, depending on total resistance value required. Adjustment accuracy is 12 to 14 times that of conventional single-turn potentiometer of equal diameter.

To win consumer preference and assure customer satisfaction, Helipot Corporation is guided by a basic policy that has proved as effective as it is simple. It is: (1) to produce components of the highest precision, and (2) to realize the economies inherent in mass production.

By following these objectives, Helipot has become the world's largest maker of precision potentiometers, producing the widest selection of single-turn and multi-turn units available anywhere.

States Helipot: "Our policy of mass producing the highest precision potentiometers practicable, in order to deliver top quality at moderate cost, is reflected in the fact that standard linearity accuracy of all our stock models, selling competitively, is held to ±0.5%. Our reliance on Driver-Harris alloys such as Nichrome V, Advance, and Karma to provide resistance windings for many of our products constitutes a strong endorsement of Driver-Harris skills and reliability."

Driver-Harris takes particular pride in having played so important a role in the Helipot story, and is fully conscious of the responsibility the confidence of this famous manufacturer imposes.

Nichrome*, Advance*, and Karma* are at your service, too; as are more than 80 other alloys developed exclusively by Driver-Harris for application in the electrical and electronic fields. We feel confident that, like Helipot, you will realize outstanding advantages by putting one or more of them to work for you. Let us have your specifications. We'll be glad to make recommendations based on your specific requirements.

*T.M. Reg. U.S. Pat. Off.

Sole producers of Nichrome, Advance, and Karma

Driver-Harris Company

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco

In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario.

MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD

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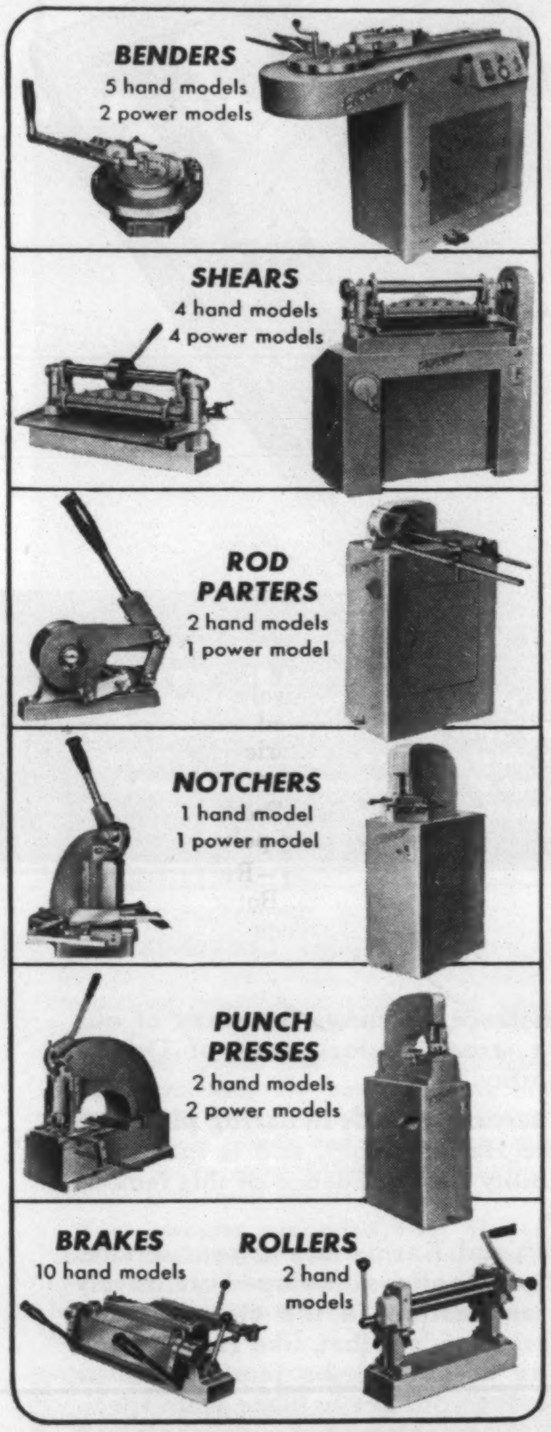
for Die-less Duplicating



BENDERS
5 hand models
2 power models

SHEARS
4 hand models
4 power models

ROD PARTERS
2 hand models
1 power model

NOTCHERS
1 hand model
1 power model

PUNCH PRESSES
2 hand models
2 power models

BRAKES
10 hand models

ROLLERS
2 hand models

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packed with ideas for making parts by "Die-less Duplicating"—the money-saving, time-saving technique created by Di-acro.

BENDING MANUAL
gives exact methods for bending processes in a variety of materials. Over 90 diagrams and charts with suggestions.

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O'NEIL-IRWIN MANUFACTURING CO.
382 8th Ave., Lake City, Minnesota

Book Reviews

(continued)

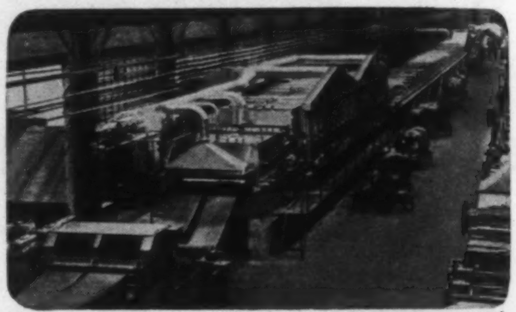
Structure of Metals. *By Charles S. Barrett. Published by McGraw-Hill Book Co., New York 36, N. Y., 1952. Cloth, 6 by 9 in., 661 pp. Price $10.00.* This second edition presents comprehensive information on the structure, properties and theories of metals and alloys, and offers thorough descriptions of the latest methods and time-saving laboratory techniques. The first part of the volume covers the fundamentals of crystallography, the apparatus and the methods of crystal structure determinations, phase diagram determination, preferred-orientation determination and stress measurement by the diffraction of x-rays, electrons and neutrons. The second part gives comprehensive summaries of the published literature on the structure of solid and liquid metals and alloys; principles governing phase diagrams; theories of alloy formations; slip, twinning and cleavage, preferred orientation resulting from the various causes that align grains; imperfections; and introductions to the fields of ferromagnetism and antiferromagnetism, electron theory of metals, theories of dislocation, strain hardening creep.

Fatigue and Fracture of Metals. *Edited by William M. Murray. Published Jointly by The Technology Press of The Massachusetts Institute of Technology and John Wiley & Sons, Inc., New York, N. Y., 1952. Cloth, 6 by 9 in., 314 pp. Price $6.00.* The 14 papers constituting this volume have been written by recognized authorities in the field and were originally presented at a special conference on the Fatigue and Fracture of Metals given in June, 1950, at the Massachusetts Institute of Technology. The discussion embraced general experience with failure of metals; specific fields in which it occurs; the internal mechanisms probably involved in fatigue damage; the significance of various metallurigical phenomena to fatigue; the potential usefulness of different research methods to disclose more about the mechanism itself and about ways of countering it in design; the direction of future research, as forecast by the speakers' specific recommendations.

ASTM Standards of Metallic Electrical Conductors. *Published by American Society for Testing Materials, Philadelphia 3, Pa., 1952. Paper, 6 by 9 in., 262 pp. Price $3.00.* Sponsored by ASTM Committee B-1 on Wires for Electrical Conductors, this latest edition presents in convenient up-to-date form the 46 ASTM standard and tentative specifications and methods of test pertaining to this field. In this special compilation, four of the standards are new, while 35 are standards that have been revised.

Pocket Manual of Arc Welding. *Compiled and edited by Lew Gilbert. Published by Industrial Book Co., Cleveland 13, Ohio. Paper, 5 by 7½ in., 172 pp. Price $1.25.* Here is a handy, pocket-sized reference for welding engineers, supervisors, inspectors and management personnel containing how-to information on welding of mild, alloy and stainless steels, as well as hard surfacing and welding of other ferrous metals. "Causes and Cures of Common Welding Troubles", "Welding Symbols and How They Are Used", "Simple Qualification Tests for Operators", and "Types of Joints and Typical Welding Positions" are but a few of the chapter titles. Included in the amply illustrated book are a wealth of valuable comparative charts which list the various types of arc welding electrodes by AWS classification and comparable electrodes made by various manufacturers.

Galvanizing
Aluminizing
Bright Annealing and
Normalizing Strip ------ Continuously



Strip in single or multiple strands up to a total width of 54" may be bright annealed or normalized, continuously, in this EF gas fired radiant tube installation. Capacity 7200 lbs. per hour.

A large capacity continuous strip normalizing, annealing and galvanizing unit. This is a combination EF gas fired radiant tube and electrically heated installation and is over 400 feet long.

We are in position to design, build and put in operation: continuous strip lines for hot or cold rolled, high or low carbon, stainless, silicon, tinplate, aluminum, brass, bronze or any other ferrous or non-ferrous strip—for bright annealing, normalizing, galvanizing, aluminizing, tinning or any other process. No job is too large or too unusual.

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